INSTRUCTIONS

for the use of instrument
Serial Number 9527 68

ESTERLINE

ESTERLINE ANGUS

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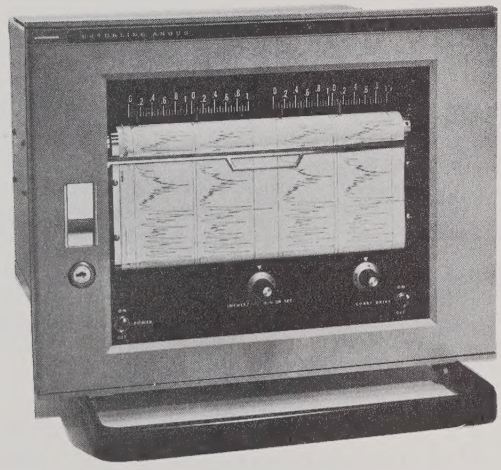
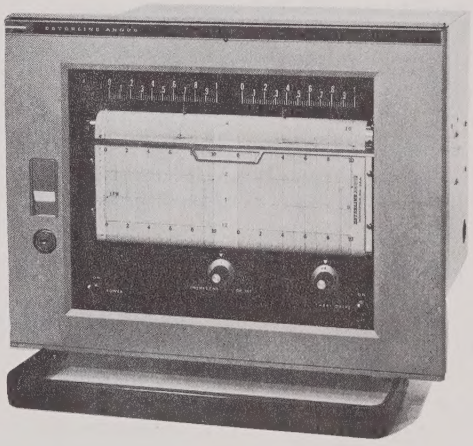
INSTRUCTION MANUAL

RECTIGRAPH RECORDERS



MODEL E1104R



MODEL E1102R

NOTE: FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED IN A SEPARATE ENVELOPE AT THE BACK OF THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED FOR YOUR RECORDER WILL BE LISTED ON THE DATA SHEET AND WILL BE FOUND IN THE APPENDIX OF THIS MANUAL.

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PART 1
GENERAL INSTRUCTIONS

SECTION I - DESCRIPTION

Esterline Angus Series "E" Recorders are designed for permanent flush installation in relay racks, switchboards, or panels. The instrument is also supplied with brackets for wall mounting and may be adapted for bench-top use with the addition of optional laboratory feet.

The sturdy, rust-proof case is compact for a wide-chart instrument, and the door has a large viewing window as well as a recessed latch and lock for a completely flush appearance (see Figure 1-1).

Some of the standard optional case features offered in the Series "E" line include internal fluorescent or incandescent lighting (mounted on chassis), side carrying handles, and rubber laboratory feet with an anti-tip bar.

The chart drive module tilts down for chart loading and for access to other chassis components. The entire chassis slides forward to service position for internal inspection, zero adjustments, or access to the inking systems. With the chassis in the service position, stops on the chassis runners prevent accidental overrunning of the slides. When used with the optional side-carrying handles and laboratory feet, an anti-tip bar at the front of the case prevents the instrument from tipping forward when the chassis is pulled out.

While each instrument is shipped from the factory well-calibrated and in first-class operating condition, the above features greatly simplify routine maintenance and servicing. To preserve the factory calibration and adjustments, the precautions noted in the following section should be carefully observed during unpacking and installation of the instrument.

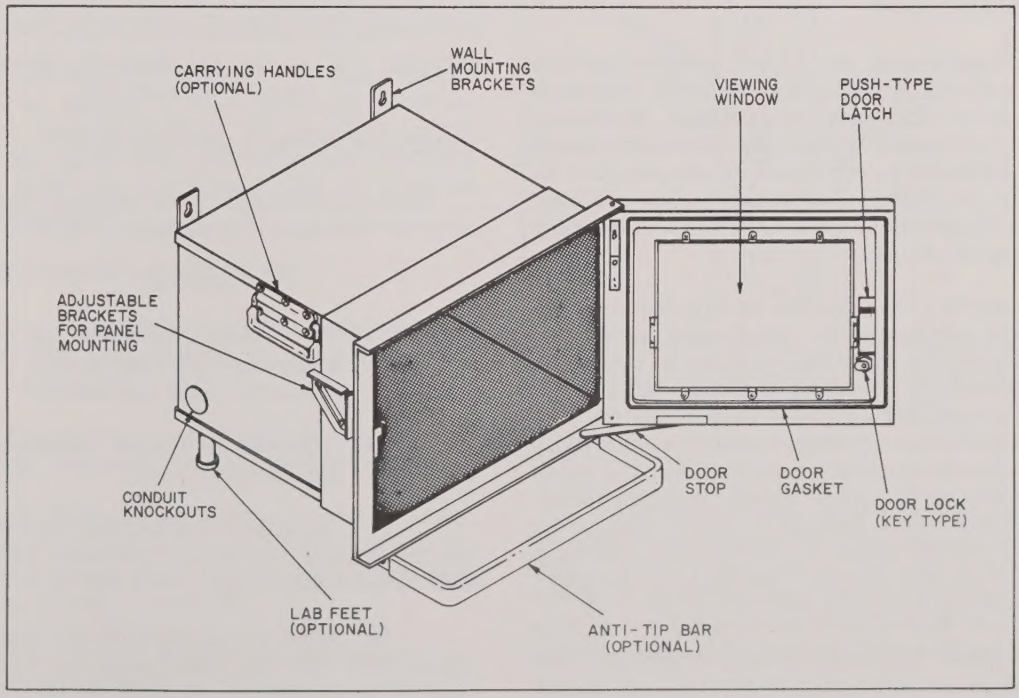


FIGURE 1-1. Major Features Of The Series "E" Instrument Case.

SECTION II - INSTALLATION

UNPACKING

A packing slip listing all enclosed items is included with each shipment of a new instrument. Consult this slip and check off the items as they are unpacked. If any part is missing, go through the packing material carefully before it is discarded. After removal from the packing case, inspect the entire assembly for physical damage.

CAUTION

Do not attempt to operate a damaged instrument. See installation procedure before removing shipping fasteners.

If the shipment has been damaged in transit, notify both the carrier and Esterline Angus at once.

NOTE: Retain Masonite piece of packing from bottom of chassis assembly for use in future chassis removal.

INSTALLING CASE

The instrument should be mounted upright and in a clean, well-lighted location. The area must be free of excessive dust, steam, moisture, smoke or corrosive fumes. The recorder should not be subjected to extremes of temperature or humidity. In addition, it should not be mounted close to large transformers or conductors carrying high currents.

The depth of the case is 14-7/16 inches from the inside surface of the front mounting flange. Space behind the mounting panel must, therefore, be sufficient to accommodate this dimension, plus additional wiring space when required. For panel installations (except racks with removable panels) clearance must be available at the sides of the case to facilitate mounting procedures. Without forced-air cooling, space must also be provided on all sides of the case to maintain adequate air circulation. The ambient temperature should not exceed 120°F.

The panel mounting brackets supplied with the instrument are suitable for use on panels thicknesses up to 1-1/2 inch (see Figure 1-2).

If the paneling material is thin and of a large area, additional case supports may be necessary (consult the factory).

Panel cutout requirements are approximately 11-7/8 inches in height and 16-1/8 inches in width. Additional mounting holes or slots are not required. See Figure 1-5 for mounting dimensions.

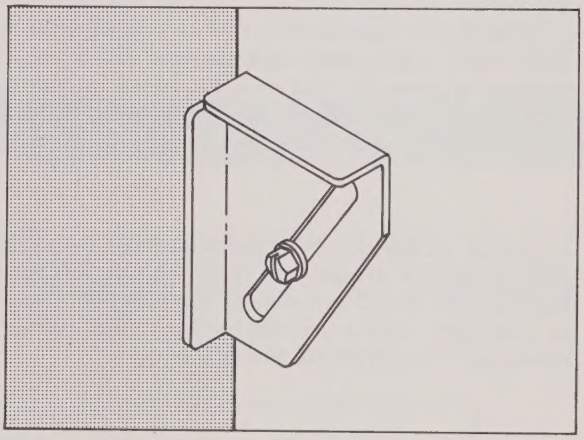


FIGURE 1-2. Adjustable Mounting Bracket For Panel Installations.

PANEL MOUNTING PROCEDURE

After providing the panel cutout (Figure 1-5), proceed with panel mounting as follows:

CAUTION

Do not remove tie-downs or shipping tags which may protect components during installation.

(a) Remove hex-head mounting bolts from both sides of the case.

(b) Examine case to make sure all components are in operating condition. Also check door hinge action, door latch and lock.

(c) Insert case through the front-panel cutout with case door hinging to the right. Hold case so that inside of flange is flush with front surface of panel.

(d) Place one mounting bracket in position against inside of panel on one side of the case. The slot in the bracket must line up with the (1/4-28) hole in the side of the case.

(e) Insert the (1/4-28) hex-head mounting bolt (previously removed) through the bracket slot and tighten into threaded hole (Figure 1-2).

(f) When the bolt is finger-tight, force the bracket forward by tapping so that it presses firmly against the inner surface of the mounting panel. Tighten bolt securely with a wrench or large screwdriver.

(g) Mount the other bracket to the opposite side of the case in a similar manner.

(h) If the panel is of the removable type, it may now be installed in its permanent position with the case attached.

CAUTION

Do not attempt to slide out the chassis or tilt the chart drive module down until the case is securely anchored in place.

(i) Remove all tie-downs and shipping tags as directed on tags or on the instruction sheet affixed to the door glass.

If the instrument is likely to be subjected to vibration or shock, it is recommended that an additional support bracket be installed at the rear of the case. The wall-mounting brackets supplied with the instrument may be used to attach this support.

WALL MOUNTING PROCEDURE

If the instrument is to be mounted directly to a wall or panel without the cutout recess, proceed as follows:

(a) Remove four flat-head screws securing top brackets to the rear of the case.

(b) Turn the two top mounting brackets so that the slotted holes are up and secure them in position using the four (1/4-28) flat head screws previously removed.

NOTE: See that the single bracket at the bottom center of the case is also secure. Refer to Figures 1-3 and 1-4 for methods of mounting.

(c) Locate and form two top mounting holes in the wall to accept 5/16 inch bolts, and one lower hole to accept a 1/4-inch bolt. Dimensions for these holes are shown in Figure 1-5.

CAUTION

Wall or bulkhead must have sufficient strength and rigidity to support weight of the instrument.

(d) Install two 5/16 inch diameter steel bolts into the two top mounting holes in the wall. Large washers, or a retaining plate should be used if the wall is uneven or if the wall is not solid. Leave bolt heads out far enough to accept mounting brackets.

(e) Make all electrical connections to the rear of instrument. Refer to "CONNECTIONS" in this section. If external lead lengths permit, the rear connection panel may be made to come forward with the removable chassis by merely loosening the two screws on each side of the panel.

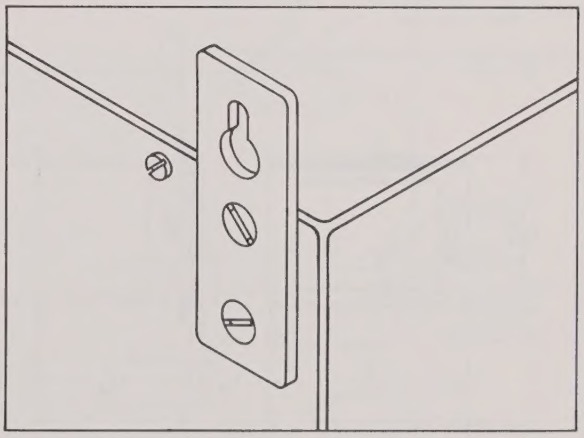


FIGURE 1-3. Hanger-Type Mounting Brackets For Wall Installations.

(f) Examine the case to make sure that all operating components are in good condition (door, latch, lock, etc.). Do not remove tie-downs or shipping tags which are provided to protect components during installation. Make a final inspection of all connections and lead dress.

(g) Hang case on wall mounting bolts and tighten until brackets are held securely.

CAUTION

Keep case door closed until instrument is anchored firmly to the wall.

(h) Attach lower mounting bracket to wall using a 1/4-inch (Dia.) steel bolt.

(i) Remove all tie-downs and shipping tags as directed on the tags or on the instruction sheet affixed to the door glass.

If the instrument will be subjected to vibration or shock, it is recommended that an additional support bracket be installed at the front of the case. The front flange of the case, or the panel mounting holes on each side of the case may be useful in fabricating a front support.

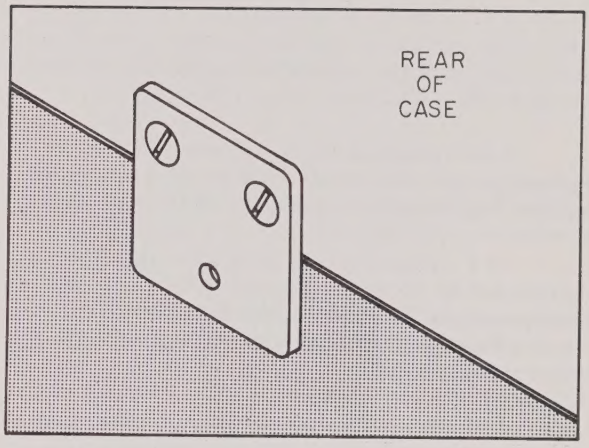


FIGURE 1-4. Lower Mounting Bracket For Wall Installations.

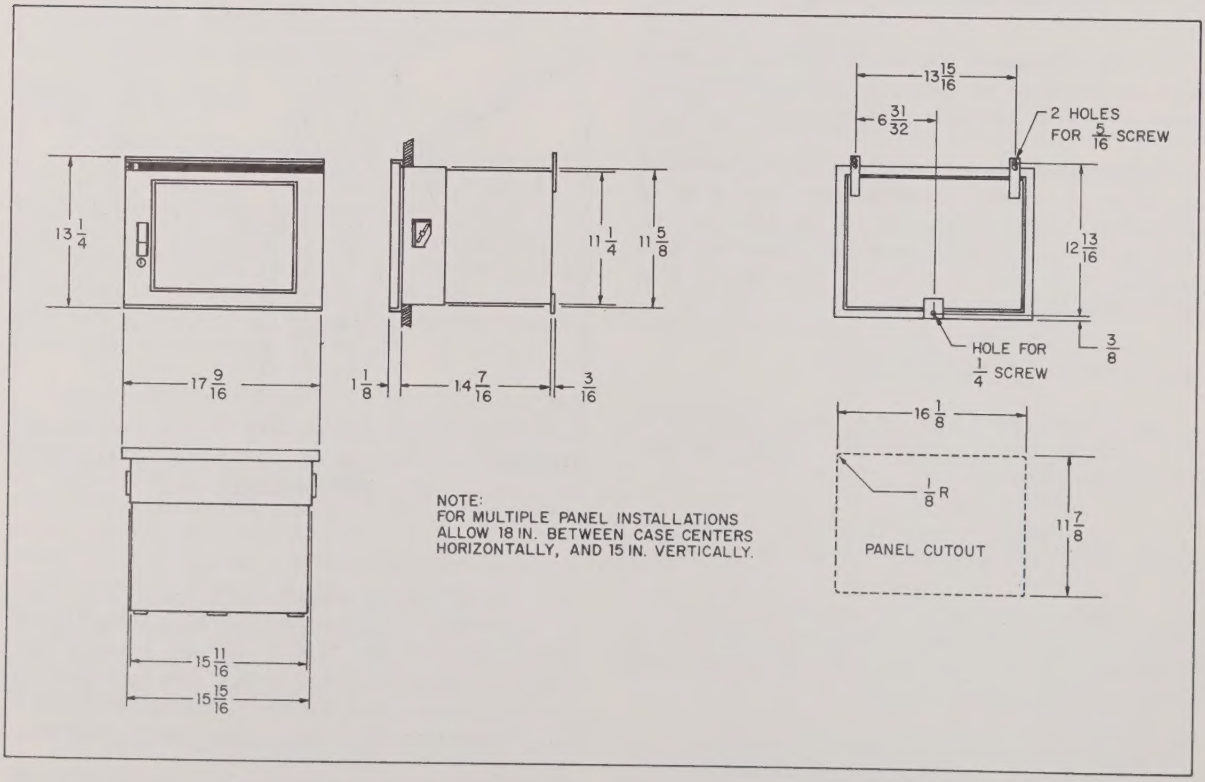


FIGURE 1-5. Mounting Dimensional Diagram For Case Installation.

BENCH TOP USE

Two kits are available to facilitate the use of these recorders as portable laboratory instruments. Kit No. 51605-3 consists of carrying handles with installation parts and Kit No. 51605-1 provides laboratory feet for bench top use with an anti-tip bar which prevents the instrument from tipping forward when the chassis is pulled out to its service position. When used in this manner, electrical connections can be made to the terminal panel by removing the plate at the back of the instrument.

To install handles, or lab feet, remove the case door as directed in this Section and then remove the entire chassis as directed in Part 3, Section III under DISASSEMBLY. Drill holes in the case as shown in Figure 1-6 and tap where required. Install feet and anti-tip bar with the hardware provided, using Figure 1-6 as a guide.

CONNECTIONS

Before making electrical connections, open the case door and see that all power switches are OFF. Refer to the terminal code plate on the case and to connection diagrams found in Part 3 of this manual for complete wiring information.

> NOTE: When accessories or special attachments form a part of the recorder system, their installation and wiring will be found in the APPENDIX at the back of this manual.

The ground terminal must be connected directly to a good building ground, such as a cold water pipe. DO NOT use conduit as the only ground connection. If the case is mounted on an insulated panel, a connection must also be made from the metal case to a convenient building ground.

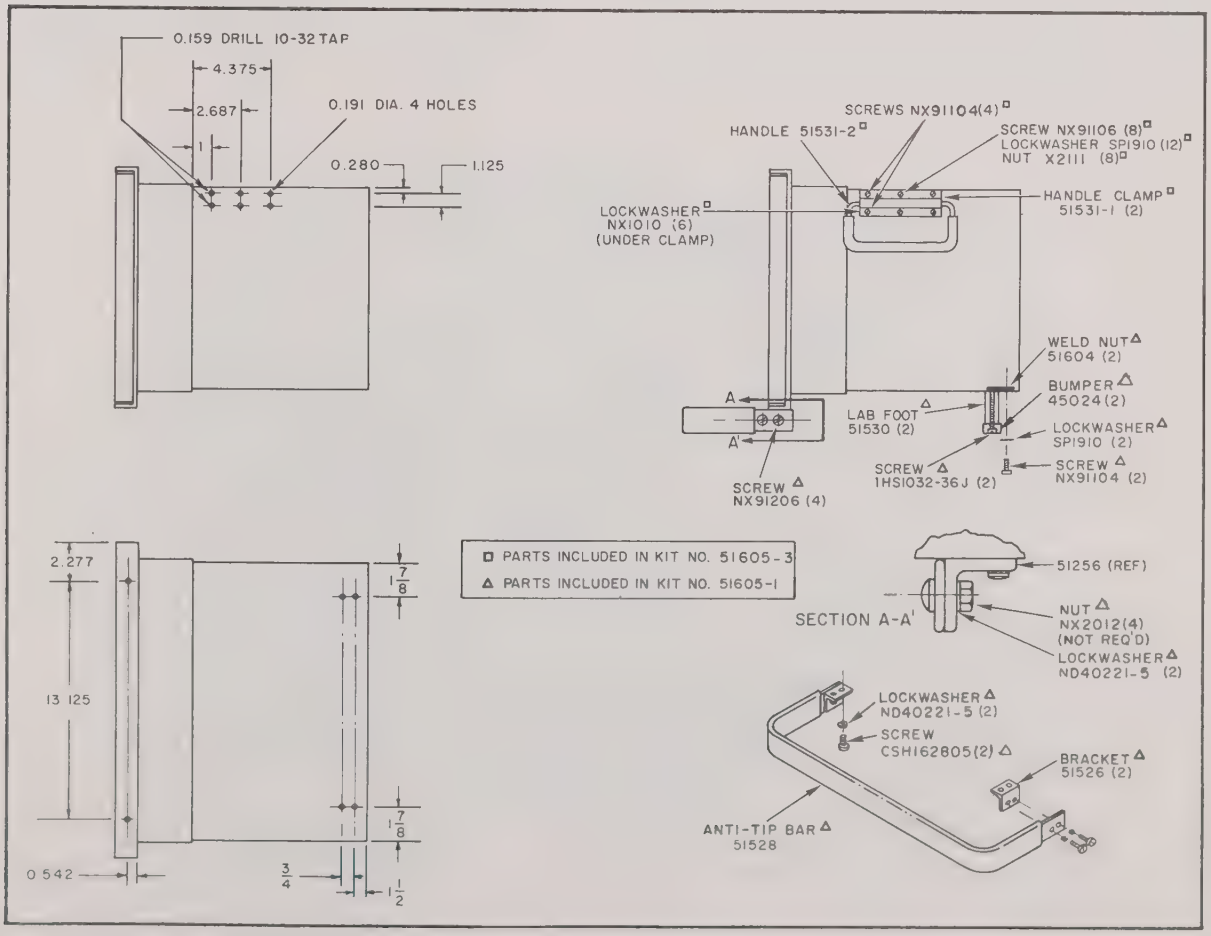


FIGURE 1-6. Installation Of Lab Feet And Carrying Handles.

All wiring should be made through rigid conduit. To relieve strains, however, approximately 16 to 18 inches of flexible conduit should be used to connect to the instrument case. NEVER enclose the signal input and power leads in the same conduit since measurement errors may result from AC pickup.

CASE DOOR REMOVAL

The Series "E" case is made virtually dust and moisture proof by its door being completely sealed with a rubber gasket. This feature not only protects the precision internal mechanism from adverse environments, but also stabilizes the ambient temperature within the case. A constant operating temperature becomes very important when measuring and recording low-level signals.

In some applications, a sealed case is of no major importance and the operator may find it more convenient to remove the door to take continuous advantage of the tilt-out writing table or to perform periodic adjustments.

The complete door assembly may be removed from the case by the following procedure:

(a) Open the door and locate the hinge pin retracting mechanism in the upper left hand side (as seen from inside).

(b) Press button in and slide the mechanism down.

(c) Tilt the outer end of the door down until top edge of door clears the case flange, then lift up to remove door and stop-arm bracket.

CAUTION

Do not lose spacing washers when removing the door. Note number and location of washers used.

PART 2
CHART DRIVE INSTRUCTIONS

SECTION I - DESCRIPTION

This part of the instruction manual covers the Chart Drive portion of the recorder. The chart drive is an accurate and reliable paper-propelling mechanism which has been especially designed for long trouble-free operation. It is an electro-mechanical device that converts electrical energy into linear physical motion through the use of a motor power source and various gear assemblies. The Series "E" chart drives are offered in single as well as multiple speeds to meet all applications of the user. Any given chart drive assembly will include a motor (or motors), a transmission, a chart transport mechanism, and optional accessories when ordered.

The POWER switch on all recorders routes line voltage to the CHART DRIVE switch and supplies a source of power to the measuring systems when required. This makes it possible to operate or warmup internal systems for any desired length of time without waste of chart paper and ink.

As shown in Figure 2-1, the Series "E" drives are designed for easy maintenance. The entire assembly tilts down to facilitate chart loading and all parts are readily accessible for adjustment, cleaning and lubrication. Motor lubrication is also made possible without removal from the motor power module. The chart trans-

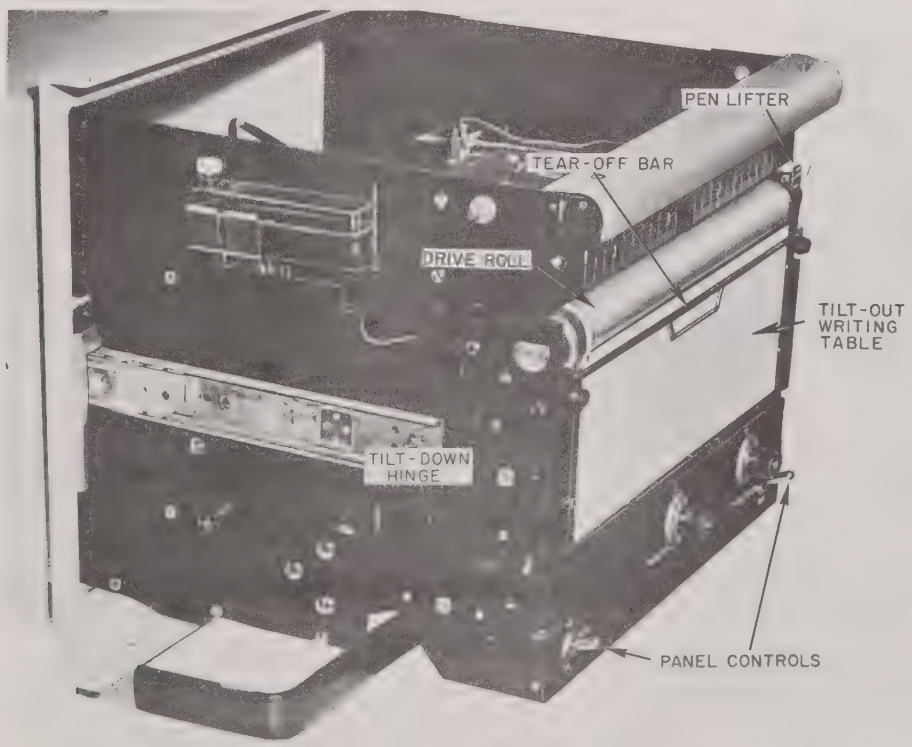


FIGURE 2-1. Chart Drive Features.

TABLE 2-1

TECHNICAL SPECIFICATIONS

ENERGY SOURCE	Synchronous Electric Motors
Timing Base	Power Line Frequency
TRANSMISSIONS	Mechanical Gear Types
Single Speed (ET-300)	Optional Hr. or Min. Feed Rate*
Two Speed (ET-318)	Optional Min. and Optional Hr. Feed Rates*
Five Speed (ET-303)	Five Selectable Hr. Feed Rates
(ET-309)	Five Selectable Min. Feed Rates
Ten Speed (ET-321)	Five Min. and Five Hr. Selectable Feed Rates
15 Speed (ET-327)	Five Hr., Five Min., and Five Sec. Selectable Feed Rates
*Manual Change Gears Supplied.	
STANDARD FEED RATES	OPTIONAL (Per Unit Time)
Hourly Range	1/2 to 960 Inches Per Hr.
Minute Range	1/4 to 16 Inches Per Min.
Second Range	1/2 to 8 Inches Per Sec.
ALTERNATE FEED RATES	OPTIONAL (Per Unit Time)
Special Hourly Range	3/4 to 1440 Inches Per Hr.
Metric Hourly Range	1.25 to 2400 cm Per Hr.
Special Minute Range	3/8 to 24 Inches Per Min.
Metric Minute Range	0.625 to 40 cm Per Min.
Special Second Range	3/4 to 6 Inches Per Sec.
Metric Second Range	1.25 to 20 cm Per Sec.
CHART TRANSPORT	Direct Gear Drive
Chart Take-Up	Automatic Reroll
Writing Table	Adjustable Tilt-Out Type
Manual Adjustments	Chart Advance and Reroll Knobs
Other Features	Chart Tearoff Bar, Built-in Tension Clutches, Tilt-down for Chart Loading
PANEL CONTROLS	Optional with Modules
Main Power (On-Off)	All Modules
Chart Drive (On-Off)	All Modules
Hour-Minute Selector	ET-318 and ET-321 Only
Feed Rate Selector	ET-303, ET-309, ET-321 and ET-327 Only
Hour-Minute-Second Selector	ET-327 Only
Optional "Local-Remote" Switch	All Instruments
STRIP CHARTS	Roll Type with Rectilinear Coordinates
Width	11 Inches (Overall)
Length	120 Feet (Continuous)
Calibration (Optional)	Four 2-3/16-inch Spans (Four - Channel)
	Two 4-1/2-inch Spans (Two - Channel)
POWER REQUIREMENT	20 to 60 Volt - Amperes
Source Voltage	120V AC ($\pm$ 10%); 240V AC (with accessory transformer)
Source Frequency	50 or 60 Hz
AMBIENT TEMPERATURE RANGE	$\pm 20^{\circ}$ to $\pm 120^{\circ}$ F
REMOTE CONTROL (Optional)	Off-On; Hr., Min., or Sec. Selection
External Switches	Terminal Connections Provided
SERVICE FEATURES	Tilt Down Transport and Removable Drive Modules

port module features a tilt-out writing table and a chart tear-off bar, while the power drive module features front-panel controls and interchangeability.

Series "E" chart drives are currently available in six standard assemblies:

No. ET-327.....(15 chart speeds)
No. ET-321.....(10 chart speeds)
No. ET-303.....(5 chart speeds)
No. ET-309.....(5 chart speeds)
No. ET-318.....(2 chart speeds)
No. ET-300.....(1 chart speed)

The speeds are offered in two English "inch" systems and one Metric "centimeter" system. As an additional option, each drive may be equipped with remote control operable at distances up to several hundred feet. Refer to the Data Sheet in the back of this manual for the type of chart drive supplied with your specific recorder.

DRIVE MODULE ET-327

The ET-327 chart drive system has the remarkable ability to furnish 15 different chart speeds, with virtually instantaneous changes being made possible by means of two simple front-mounted control knobs. As shown in Table 2-2, the slowest speed is 0.5 in./hr.; the fastest, 8 in./sec., which results in a difference factor of 57,600 between the slowest and fastest speeds. This unusual range of 15 different speeds, together with the unique ease of speed change, is achieved by the incorporation of the following design features:

1. Two synchronous electrical motors. One motor is reversible and, through the use of overrunning clutches within its gear box, serves as two individual sources of driving power. This motor is used for all "Hour" and "Minute" chart speeds. The other motor runs in only one direction and is used for all "second" speeds. Its gear box also employs a clutch but for reversal protection.

TABLE 2-2

AUTOMATIC CHART DRIVES

NO.	TYPE	IN/HR*	IN/MIN*	IN/SEC*
ET-327	15 Speed Automatic, Dial Select Speed	.5, 1, 2, 4, 8	.5, 1, 2, 4, 8	.5, 1, 2, 4, 8
ET-321-60	10 Speed Automatic, Dial Select Speed	.5, 1, 2, 4, 8	.5, 1, 2, 4, 8	
ET-321-30	10 Speed Automatic, Dial Select Speed	1, 2, 4, 8, 16 ⁄	.5, 1, 2, 4, 8	
ET-321-15	10 Speed Automatic, Dial Select Speed	2, 4, 8, 16, 32 ⁄	.5, 1, 2, 4, 8	
ET-321-10	10 Speed Automatic, Dial Select Speed	3, 6, 12, 24, 48 ⁄	.5, 1, 2, 4, 8	
ET-321- 6	10 Speed Automatic, Dial Select Speed	5, 10, 20, 40, 80 ⁄	.5, 1, 2, 4, 8	
ET-303-60	5 Speed Automatic, Dial Select Speed	.5, 1, 2, 4, 8		
ET-303-30	5 Speed Automatic, Dial Select Speed	1, 2, 4, 8, 16		
ET-303-15	5 Speed Automatic, Dial Select Speed	2, 4, 8, 16, 32		
ET-303-10	5 Speed Automatic, Dial Select Speed	3, 6, 12, 24, 48		
ET-303- 6	5 Speed Automatic, Dial Select Speed	5, 10, 20, 40, 80		
ET-309	5 Speed Automatic, Dial Select Speed		.5, 1, 2, 4, 8	

⁄ A multiplying factor is used with dial calibrations to determine these chart speeds.

*For alternate Inch Speeds, multiply figures in above table by 1.5. (Exception: The maximum speed for ET-327 drive is 6 inches per second).

For alternate Metric (cm) Speeds, multiply figures in above table by a factor of 2.5. (Example: .5, 1, 2, 4, 8 inches become 1.25, 2.5, 5, 10, 20 centimeters).

2. An ingeniously designed main transmission with five different ratios between input and output speeds. Gear ratios are selected by cam-actuated levers.

3. Overrunning clutches, each of which transmits torque in one direction but not in the other. The action of these clutches within the transmission is fully automatic and duplicates exactly the function of similar larger units in torque converters and overdrives on automobiles. The clutches are actually integral components of the transmission but are mentioned separately because of their unique application.

The three motor configurations previously mentioned, combined with the five transmission ratios, yield 15 output speeds within the dimensional limits of a surprisingly compact assembly. Basic components of the drive module are pictured in Figure 2-2.

On chart drive ET-327, line voltage is supplied to the HR-MIN-SEC switch when the CHART DRIVE switch is turned on. It will be noted that the HR-MIN-SEC switch has two MIN positions which are completely identical in function. One motor may be turned on and off by the HR-MIN-SEC switch; the other motor may have the electrical phase supplied to its quadrature winding reversed, thereby reversing its direction of rotation. The on-off capability of one motor and the reversibility of the other make it possible to supply three different RPM's to the main transmission. One must also bear in mind, of course, that the overrunning clutches are continuously functioning whenever a change of speed is called for. Both motors are precisely synchronous and are equipped with suitable gear reduction boxes so that the motor output RPM's are only fractions of the armature RPM's (the latter being exactly 1800 on 60-cycle current). The gear reduction boxes are integral with the motors and are not to be considered part of the main multi-speed transmission.

The INCHES control knob is used to mechanically select any one of five different gear ratios within the compact multi-speed transmission. This knob may be operated at will without damaging gear teeth, since progressive design makes the gear meshing permissive and not forced. The delay in meshing is negligible at all chart speeds.

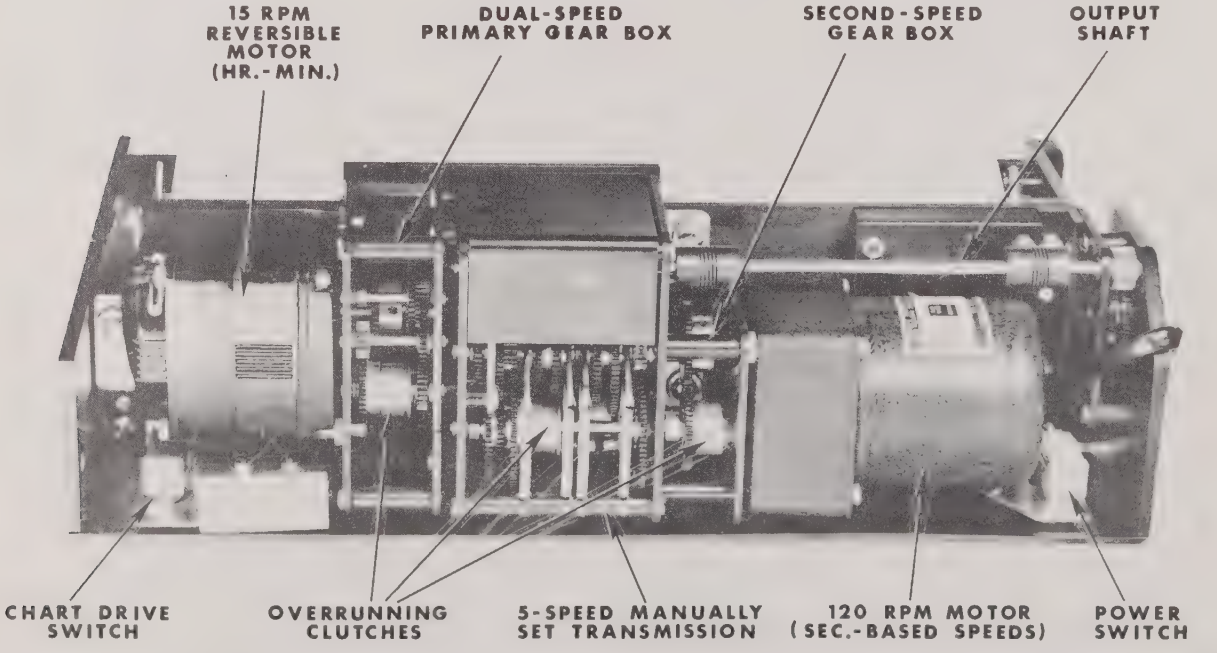


FIGURE 2-2. Drive Module ET-327 Showing Basic Components.

DRIVE MODULE ET-321

Five standard configurations of the ET-321 drive are currently available. Each configuration has 10 speeds but the assortment of speeds is optional as listed in Table 2-2.

It will be noted in Table 2-2 that each drive number has the same assortment of speeds in IN/MIN. The differences are found in the assortment of speeds in IN/HR. The INCHES control has five settings: .5, 1, 2, 4, and 8. The HR-MIN switch has two settings which are self-explanatory.

In the ET-321-60, switching the time unit selector from HR to MIN (or vice versa) automatically changes the transmission gear ratio by a factor of 60. So, for any constant setting of the INCHES selector, the chart speed changes by a factor of 60 when the HR-MIN switch is changed from one position to the other. The INCHES and HR-MIN indications are interpreted directly.

In the other ET-321 chart drives, this change in gear ratio when the HR-MIN switch is operated is not 60. For example, in the ET-321-30 the change in gear ratio is only 30. Therefore, for a constant INCHES setting, an HR-based speed on the ET-321-30 is just twice as high as on the ET-321-60, as shown in Table 2-2. The operator is reminded of this by means of the multiplying factor of two (x 2) appearing on the front panel under the INCHES selector. (It will be noted that MIN never has a multiplier on any ET-321 drive, and therefore minute-based speeds are always read directly.)

Following the same analysis, the ET-321-15 changes gear ratios by a factor of 15 when the HR-MIN switch is changed from one position to the other. So, for a constant INCHES setting, every hour-based chart speed is exactly four times as high as on the ET-321-60. The Operator is reminded of this by the multiplying factor of four next to IN/HR on the front panel. In the ET-321-15 drive, if the INCHES control is set on .5 and the time unit selector is on IN/HR x 4, the chart speed is (4 x .5) in./hr. or 2 in./hr., as shown in Table 2-2. The ET-321-6 and ET-321-10 drives have multiplying factors of 10 and 6 respectively for their hourly chart speeds.

All configurations of the ET-321 chart drive are equipped with one motor which is reversible by actuation of the HR-MIN switch. Reversing

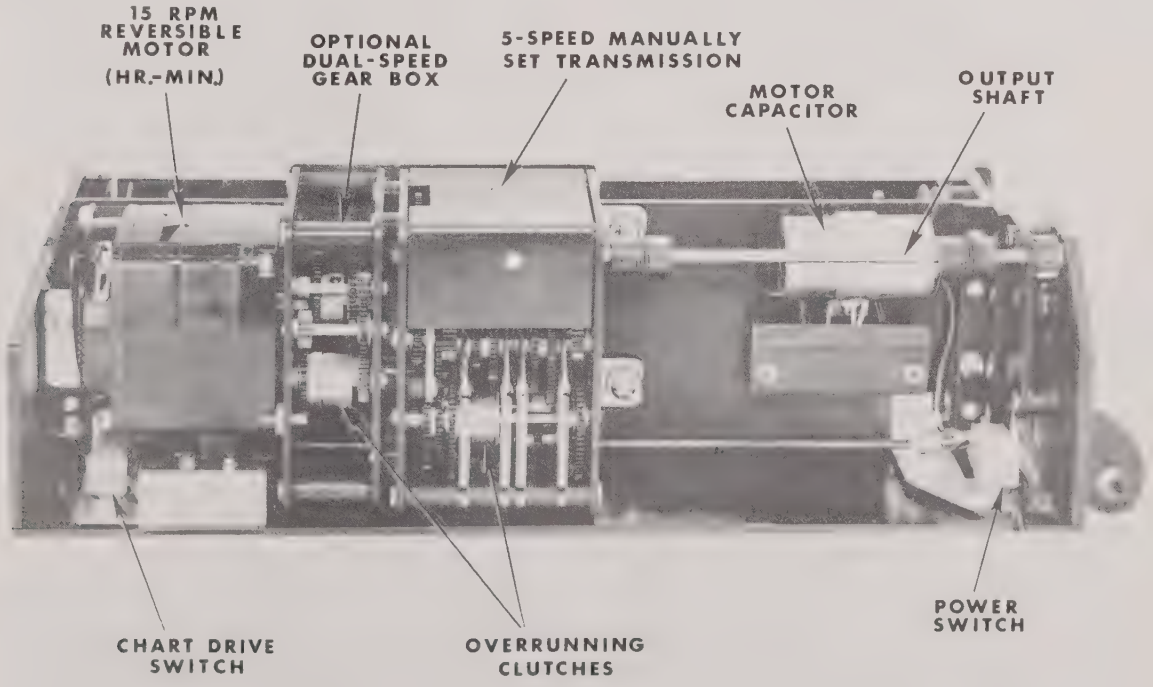


FIGURE 2-3. Drive Module ET-321 Offers The Operator 10 Chart Speeds.

the motor, in combination with overrunning clutches, brings different primary gear trains into operation so that the RPM supplied to the main transmission is appropriately changed while maintaining the same direction of rotation. Components of this drive module are shown in Figure 2-3.

The main transmission has five gear ratios which are set by the INCHES knob. The INCHES knob is purely mechanical in function. The gears may be changed at will without damage because meshing is permissive rather than forced.

It can be seen that the two-directional motor plus the five gear ratios available in the main transmission combine to furnish ten chart speeds which may be quickly selected by the operator from front-mounted controls.

DRIVE MODULE ET-318

The ET-318 chart drive is composed of a reversible 15-RPM synchronous motor driving an optional gear box equipped with overrunning clutches so as to produce two distinct forward RPM's for the main transmission. Output of the transmission may be readily changed by means of accessible external change gears. These external gears can be changed by removing the knurled nuts holding them to their shafts, removing the gears, slipping the other set of gears on the shafts, and tightening down the knurled nuts.

The HR-MIN switch reverses the motor by reversing the electrical phase supplied to the quadrature winding. The ET-318 drive is available with optional gear boxes having stepdown ratios of 60:1, 30:1, 15:1, 10:1, or 6:1. These drives are designated ET-318-60 through ET-318-6. Table 2-3 lists what chart speeds may be obtained with various gear-box ratios and manual change gears.

DRIVE MODULES ET-303 AND ET-309

Each ET-303 chart drive incorporates a non-reversible 15-RPM motor and optional single-speed gear box in combination with a five-speed transmission. The optional gear box is available in five different fixed ratios, each furnishing a specific RPM to the multispeed transmission. The cam-actuated transmission permits the automatic selection of any five IN/HR speeds listed in Table 2-2. These drive modules are designated ET-303-60 through ET-303-6. The single-speed gear boxes are available as IN/HR (ET-303-60), IN/HR x 2 (ET-303-30), IN/HR x 4 (ET-303-15), IN/HR x 6 (ET-303-10) and IN/HR x 10 (ET-303-6). The multiplying factors of 2, 4, 6, and 10 are used with the fixed dial calibrations to determine the chart speed in "inches" for any given ET-303 drive.

The selection of speeds for each specific drive is accomplished by the positioning of the INCHES dial on the front panel of the drive module. The INCHES dial may be changed at will since gear meshing is permissive rather than forced.

The ET-309 chart drive includes the same basic components as the ET-303 modules except only one gear box is offered for standard inch ranges. This gear box furnishes an output RPM to the selectable transmission which in turn produces a fixed group of minute speeds rather than hour speeds. In all other respects the ET-303 and ET-309 drive modules are the same.

DRIVE MODULE ET-300

The ET-300 chart drive consists of a synchronous motor driving an optional single-speed transmission. A selection of chart speeds is made possible through the use of either a 1-RPM motor or a 15-RPM motor, in conjunction with three different transmissions -- designated as A, B, or C. Thus, a drive having a 1-RPM motor and a B transmission will be designated as ET-300-1B. Other combinations are identified in a similar manner as shown in Table 2-4.

In addition to the various motor-transmission combinations, the output of each transmission is also made variable by means of manual change gears. These gears are readily accessible and are interchangeable in the field. Each change gear is held in place by a knurled nut, thus making it possible for the operator to convert chart speeds without tools. To determine the speeds offered by these change gears, see Table 2-4. Other special chart speeds may be made available -- consult factory for details.

TRANSPORT MODULE

From the motor drive module to the chart reroll in the transport module, advanced Esterline Angus designing has combined the entire chart drive system on one single assembly which tilts down to expose the back for chart loading or for service to the drive components. Continuous drive energy is transmitted through

this module by simple straightforward spur gearing. This eliminates awkward problems of power transfer through worm gears, which often operate under marginally heavy loading because of restrictions on their size, etc. Also, there is no need for a complicated hinge design to accommodate a power shaft.

The chart transport assembly can be tilted down without disturbing the chart paper in any way. When the chart drive is tilted down and then reclosed, the pens will resume writing in their correct positions, since they are automatically lifted when the drive tilts down, and are then lowered when it is returned to recording position.

Provision is made for moving one flange of the roller cylinders longitudinally without tools, so that adjustment may be made to prevent chart weaving. The movable flange should always be kept adjusted snugly against the left edge of the paper. This is one more Esterline Angus feature assuring smooth operation and an undamaged chart.

TABLE 2-3

DRIVE ET-318 CHART SPEEDS

MANUAL CHANGE GEARS			DRIVE NUMBER AND SPEEDS IN INCHES									
COLOR CODE	TEETH IN DRIVE GEAR	TEETH IN DRIVEN GEAR	ET-318-60		ET-318-30		ET-318-15		ET-318-10		ET-318-6	
			HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
GOLD	18	72	1	1	2	1	4	1	6	1	10	1
GREEN	30	60	2	2	4	2	8	2	12	2	20	2
RED	45	45	4	4	8	4	16	4	24	4	40	4
GREEN	60	30	8	8	16	8	32	8	48	8	80	8
GOLD	72	18	16	16	32	16	64	16	96	16	160	16

NOTE: For alternate standard inch speeds, multiply figures in above table by 1.5. For alternate standard metric speeds, multiply figures in above table by 2.5 (Example 1, 2, 4, 8, 16 inches become 2.5, 5, 10, 20, 40 cm).

TABLE 2-4

DRIVE ET-300 CHART SPEEDS

MANUAL CHANGE GEARS			DRIVE NUMBER AND SPEEDS IN INCHES PER HOUR			
COLOR CODE	TEETH IN DRIVE GEAR	TEETH IN DRIVEN GEAR	ET-300-1A	ET-300-1B	ET-300-15A	ET-300-15C
GOLD	18	72	1	1.5	15	60
GREEN	30	60	2	3	30	120
RED	45	45	4	6	60	240
GREEN	60	30	8	12	120	480
GOLD	72	18	16	24	240	960

NOTE: For alternate standard inch speeds, multiply figures in above table by 1.5. For alternate standard metric speeds, multiply figures in above table by 2.5 (Example 1, 2, 4, 8, 16 inches become 2.5, 5, 10, 20, 40 cm).

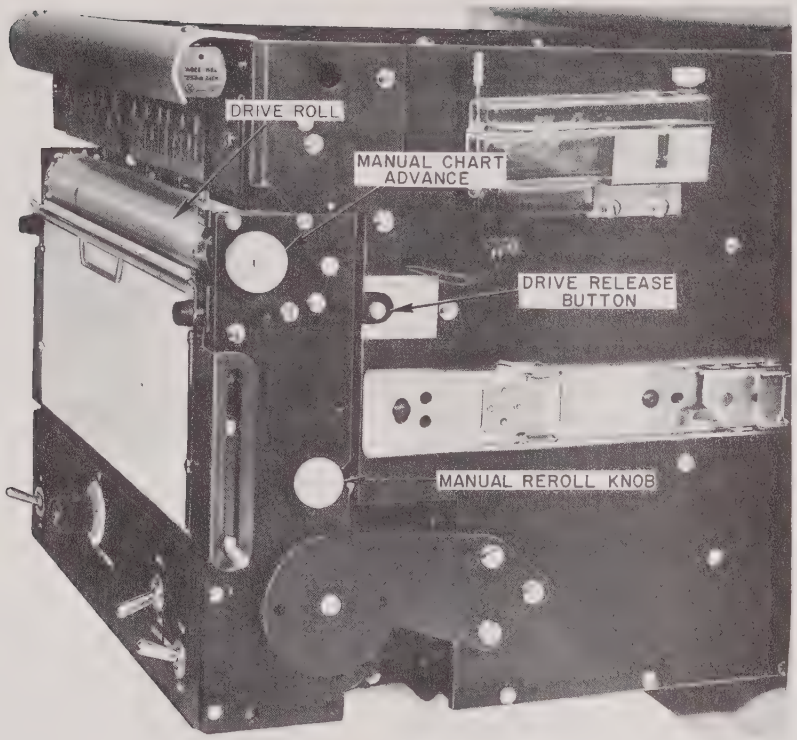


FIGURE 2-4. Chart Drive Components (In Recording Position).

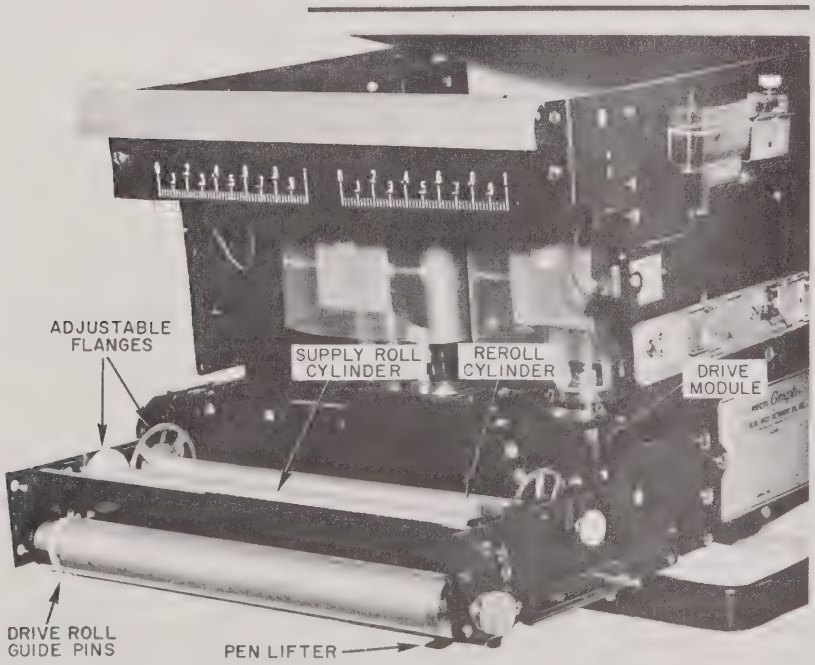


FIGURE 2-5. Chart Drive Components (In Service Position).

The universal chart transport is used with all optional chart drive modules. The transport begins where the transmission or power module ends, and includes all components in the gear train ending with the reroll cylinder. The paper supply roll is also included in this gear train although it is actuated only by tension on the paper itself.

The three rollers in the chart transport system are the paper supply roll, the drive roll, and the reroll cylinder (Fig. 2-4). The supply roll and the reroll cylinder are accessible from the rear of the tiltdown assembly, and can be removed and re-inserted easily by manipulation of retaining clips. The supply roll has a very lightly loaded friction clutch which constantly slips in use so that a slight but firm tension is maintained on the paper being unwound. A slightly heavier clutch in the reroll cylinder also constantly slips in use because gearing is designed so that, under all normal conditions, the reroll cylinder will try to take up paper faster than it can be supplied. A knob is furnished for manual rotation of the reroll cylinder.

The drive roll, located at the top of the chart drive assembly, dominates the motion of the paper. Although a clutch is provided to permit manual rotation by means of a knob, the clutch loading is sufficiently heavy to guarantee that no slippage will occur in normal operation. The paper is "geared" to the drive roll by holes which fit guide pins on the drive roll. No attempt should be made to rotate the drive roll by pulling on the paper, since the holes in the paper will invariably tear out.

Any reasonable amount of slack created in the paper by inspection, etc., will be taken up again in a matter of seconds by the automatic reroll action. The operator may, of course, take up excessive slack by rotating the reroll cylinder manually. Care should be taken, however, that only a minimum of forward torque is applied as the paper becomes snug. It is just as well to leave the final inch or two of take-up to the instrument itself.

A conveniently located pin at the right side of the assembly enables the operator to swing out the writing table to about a 45-degree angle as shown in Figure 2-6. Ingenious geometry and accurate machining cause the table to lock itself into normal operating position without the use of any breakable clips, notches, springs, etc.

Swinging out the table will automatically draw paper with it by a slight reversal of the reroll action. When the table is returned to its normal position, the slack in the paper will be taken up automatically. To speed up this action, however, the operator may elect to use the manual reroll knob.

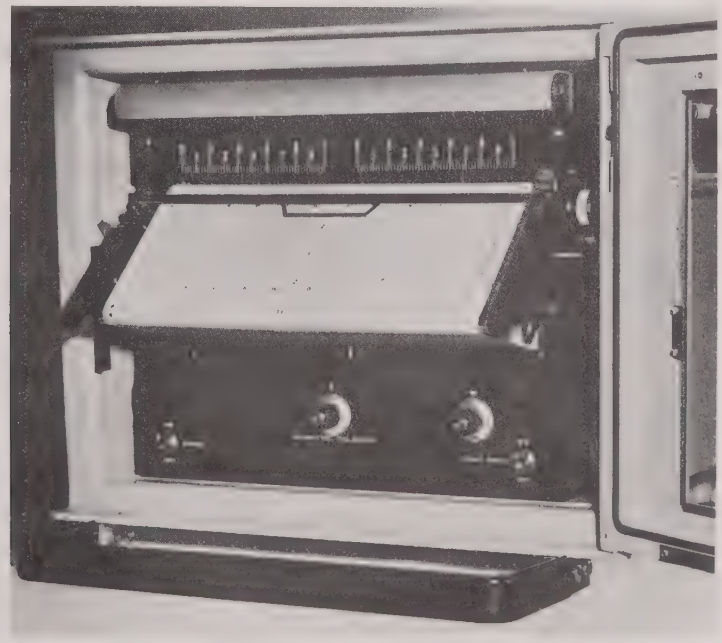


FIGURE 2-6. Writing Table Extended From Chart Drive.

SECTION II - OPERATION

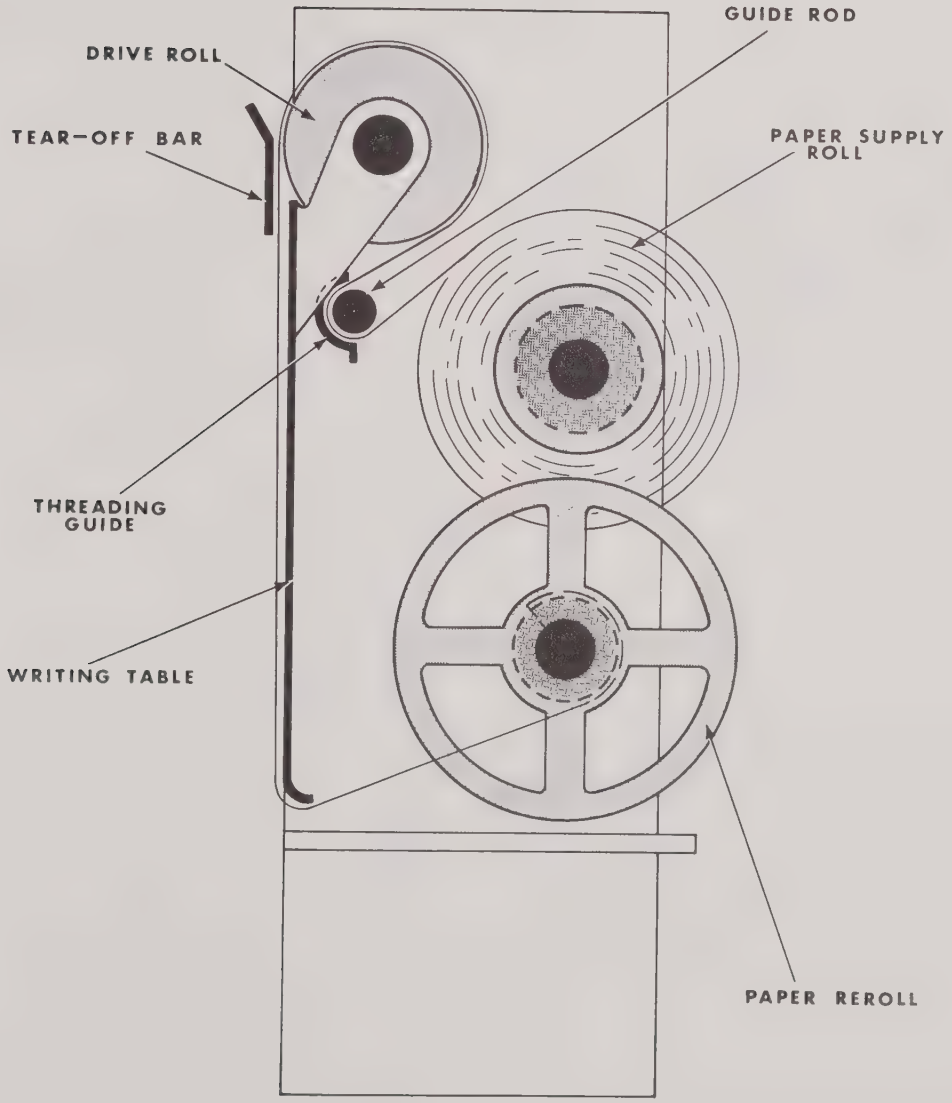


FIGURE 2-7. End View Of Transport Showing Rollers And Chart Routing.

GENERAL

Following are detailed instructions for installing chart paper, operating front-panel controls, and removing rerolled chart from the instrument. Only Esterline Angus precision charts must be used in this recorder to maintain guaranteed accuracy and to insure optimum performance. Before preparing the instrument for operation see that all packing materials have been removed and that the case is properly installed. It is recommended that chart drive power be turned off and that the measuring system be de-energized.

CHARTING

FIGURE 2-8. Open case door and pull chassis assembly part way out of the case. Press CHART DRIVE RELEASE button at right side of chassis and permit drive to tilt down as far as possible. Pull straight out on chart supply cylinder and remove from drive transport as shown.

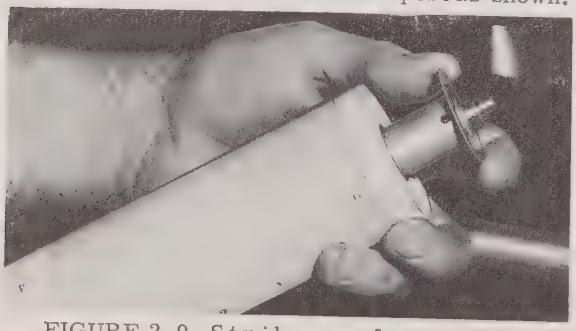


FIGURE 2-9. Strike perforated end of paper roll on flat surface to assure that fiber core and edges of the paper are flush. Separate sections of supply cylinder and insert section with keyed end into perforated end of paper supply roll as illustrated. Make sure the small pin on the cylinder engages the notch in the core of the paper supply roll. Insert the other section of the cylinder into the opposite end of the paper roll and press in all the way.

FIGURE 2-10. Tear, or cut, leading edge of paper to a "V" shape and turn up point slightly. With perforated end of the supply roll to the left, pass the "V" end of paper under the round guide rod, then up and over the drive roll.

FIGURE 2-11. Pull a few inches of paper from the roll and snap the supply cylinder into its original position in the transport assembly.

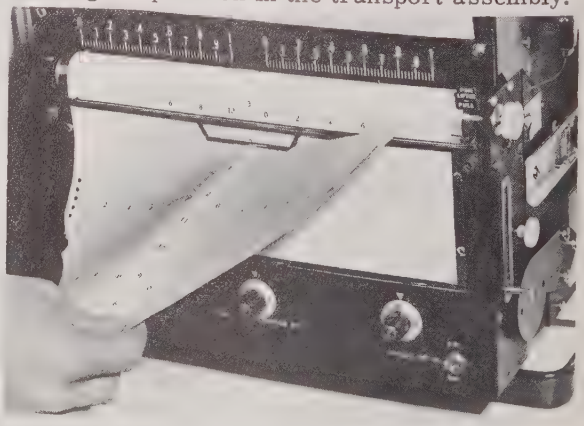


FIGURE 2-12. Tilt the transport assembly up to its normal position and route the paper down under the tear-off bar. Engage perforations of paper with pins of drive roll and advance paper with the drive roll knob. Tear off a portion of the chart by pulling it sharply against the tear-off bar as shown.

CAUTION

Always use drive roll knob to advance chart. Do NOT use reroll knob.

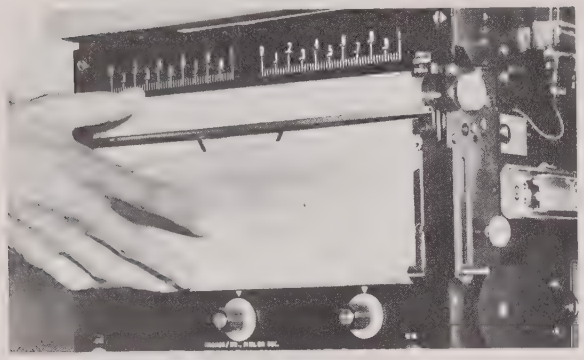


FIGURE 2-13. Advance several more inches of paper using the drive roll knob; then insert the end of the paper under the bottom of the writing table as pictured here.

FIGURE 2-14. Tilt the transport assembly down and pull the end of the paper over the reroll cylinder. Make sure that the slots of the cylinder halves are in alignment and insert tab at leading edge of paper into the cylinder slot.

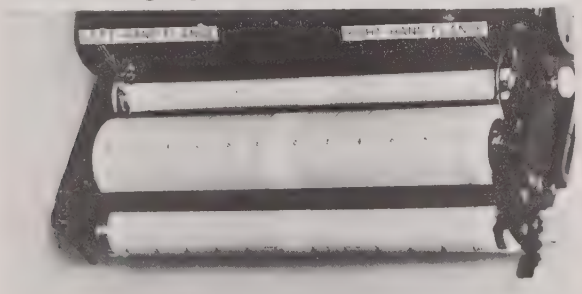


FIGURE 2-15. Make sure that the perforated edge of the paper touches the left-hand flange of the reroll cylinder. Hold left-hand flange and advance reroll knob until paper is clamped in slot and wraps on reroll cylinder. Press right-hand flange inward until it butts against unperforated edge of paper. Raise the assembly and lock it in its upright position. The transport is now charted and ready for operation.

OPERATING CONTROLS

After making the proper electrical connections, installing the chart, and preparing the writing system for recording, the chart drive may be put into operation in the following manner.

DRIVE MODULE ET-300

1. Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2. Turn on CHART DRIVE switch. This energizes the chart drive motor and causes the chart paper to be driven at a speed determined by the optional style of drive employed.

3. To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULES ET-303 AND ET-309

1. Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2. Select chart speed by setting the INCHES PER MINUTE or INCHES PER HOUR dial to desired speed.

NOTE: The front-panel dial will be calibrated in centimeters instead of inches for all metric chart drives.

3. Turn CHART DRIVE switch on. This energizes the chart drive motor and causes the paper to be driven at the speed indicated by the front-panel dial.

4. To change speed, turn the INCHES PER MINUTE or INCHES PER HOUR knob to the desired speed. This may be done at any time, whether the chart is being driven or not.

5. To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULE ET-318

1. Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2. Place HR-MIN switch in desired position.

3. Turn on CHART DRIVE switch. This applies AC excitation to one winding of the chart drive motor and also to the HR-MIN switch, which routes power to the quadrature winding of the reversible motor in a phase determined by the setting of the switch. The chart will now begin moving at a rate determined by the basic style of drive and the HR-MIN setting.

4. To change chart speed, actuate the HR-MIN switch. This switch may be operated at any time -- with power on or off.

5. To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULE ET-321

1. Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2. Select chart speed by setting INCHES dial and HR-MIN switch to desired positions.

NOTE: The front-panel dial will be calibrated in centimeters instead of inches for all metric chart drives.

3. Turn on CHART DRIVE switch. This energizes one winding of the reversible motor and also applies power to the HR-MIN switch, which routes power to the quadrature winding of the motor in a phase determined by the setting of the switch. The chart will now move at the selected rate.

4. To change chart speed, actuate the dial selector and/or the HR-MIN switch. These controls may be changed with power on or off.

5. To stop the chart paper, place the CHART DRIVE switch in its OFF position.

DRIVE MODULE ET-327

1. Turn on POWER switch. This routes AC power to the CHART DRIVE switch and energizes the measuring system if power is required for these elements. With this switch on, an internal power supply or amplifier is permitted to warm up without the chart drive operating.

2. Select chart speed by setting the INCHES selector dial and the HR-MIN-SEC selector switch to the desired positions.

NOTE: The front-panel dial will be calibrated in centimeters instead of inches for all metric chart drives.

3. Turn on CHART DRIVE switch. This supplies excitation to the HR-MIN-SEC selector which, in turn, distributes power to the drive motors. The reversible hour-minute motor runs continuously; while the second-speed motor operates only when the panel selector dial is in the SEC position. The chart will now begin to travel at the rate indicated on the dial knob as related to the time unit selected on the HR-MIN-SEC selector.

4. To change chart speed, rotate either panel selector to the desired position. These controls may be operated at any time -- with power on or off.

5. To stop the chart paper, place the CHART DRIVE switch in its OFF position.

MANUAL CHANGE GEARS

On the ET-300 and ET-318 modules, it is necessary to manually change the drive gears when different chart speeds are required. No disassembly is required for the change except the removal and replacement of gears. To change chart speed, proceed as follows:

1. Pull the chassis out to its service position.

2. Consult the table on the top of the transmission assembly and select gears for the desired chart speed.

3. Remove the knurled locking nuts from the end of the transmission assembly and remove gears from shafts. Press new gears on shafts and reinstall knurled nuts tightening only by hand. Note the illustration on the instruction plate which shows relative position of the gears. Gears may be identified by color and by the number of gear teeth. Save unused gears for future use.

REMOTE CONTROL

As an optional feature, all Series "E" chart drives may be equipped with remote control. External remote switches or contact closures may be used to turn on or turn off the chart drive, as well as to select hour-minute and hour-minute-second functions whenever they are included as part of the drive system. When the instrument is wired for remote control, the POWER switch must be on for both local and remote operation.

A recorder with remote control will have provisions for external connections located on the rear of the instrument case. A "LOCAL-REMOTE" Mode switch may be supplied internally, or wired externally by the user of the instrument. The Mode switch (connected according to Figure 3-13. Maintenance, PART 3) affords completely foolproof operation. When operating the chart drive from a remote location, the Mode switch is placed in its "REMOTE" position. The drive is then controlled only by external contact closure, and internal switching will have no effect. Conversely, when operating the drive at the instrument, the Mode switch is placed in its "LOCAL" position. In this case, the drive is controlled only by the panel switches and external contact closures will have no effect.

> NOTE: Multiple-speed Drives ET-303, ET-309, ET-321, ET-327 have rate selector dials which, of course, must be manually operated at the front panel of the instrument.

All remote contact-making devices and external wiring must be furnished by the instrument owner. The number and type of external contact closures required will depend upon the number of remote functions desired and the nature of the particular installation. All internal remote-control wiring is shown on the power and accessory wiring diagram in this manual.

CHART REMOVAL

Changing charts promptly assures continuous records and also prevents damage to components of the recorder. If the writing elements are permitted to come in contact with the drive roll, ink may flow on the roller and the tip of the writing element may become impaired.

REMOVAL PROCEDURES

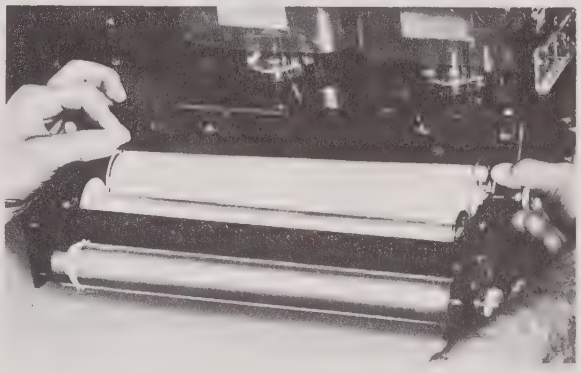


FIGURE 2-16. Open the case door, turn off power, pull chassis part way out of the case, and tilt chart drive down by pressing release button on right side of chassis. Push down on clip at each end of reroll cylinder and remove cylinder and rerolled chart from instrument.

FIGURE 2-17. Carefully remove the two sections of the reroll cylinder from the paper roll. If the paper is wound too tightly, twist cylinder as it is withdrawn.

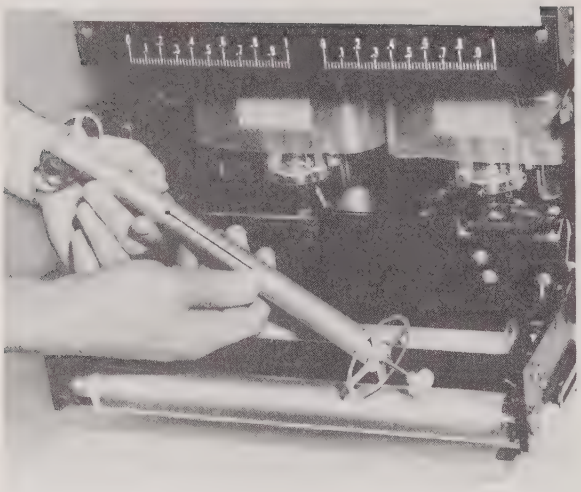


FIGURE 2-18. Telescope empty cylinder sections together, making sure slots are in alignment and snap cylinder back into transport assembly. See charting procedure to install new chart.

RECORDING CHARTS

To maintain instrument accuracy and insure optimum performance, only Esterline Angus precision charts should be used with this recorder. Standard Series "E" charts have three sets of time numbers imprinted upon them. The time numbers appearing at the center of the chart are for 1" per-hour-speeds and are marked A.M. and P.M. The time numbers appearing in the left portion of the chart are for 2" per-hour-speeds and those in the right portion of the chart are for 3" per-hour-speeds. Time numbers therefore appear every 1-, 2-, and 3-inches on the 120-ft. charts. Esterline Angus 11" charts may also be ordered with special rulings, ranges, captions and time numbers. Consult the factory for special requirements.

The chart record may be inspected at any time during operation by unwinding the paper from the take-up roller. With the chart drive in operation, the take-up system functions at all times and will reroll any portion of the chart unwound for inspection. If desired, the reroll action may be speeded up without throwing the chart out of time by manipulating the knob on the right end of the reroll cylinder.

Only the knob on the drive roll should be used to advance (or set to time) the chart paper. To assure a faster reroll action when advancing the chart manually, select a reasonably fast chart speed whenever one is available.

If the chart is to be set backwards, the clutch in the drive roll will usually slip. This is harmless, but the operator must take up the slack on the supply roll. No attempt should be made to turn the drive roll by pulling on the paper because holes in the paper will almost invariably tear out before friction of the mechanism is overcome.

Instead of having the chart paper taken up on the built-in reroll, it may be fed over the writing table and straight out of the instrument. If feeding difficulties are encountered at fast chart speeds, it may be necessary to attach a 5- or 6-ounce weight to the leading edge of the paper and permit the paper to fall freely from the instrument.

Do not pull or jerk on the chart, as this may either throw it out of time or disengage it from the pins on the drive roll. The bar across the top of the writing table may be used as a tear off edge by pulling the chart straight upward from one side to the other.

To help insure a continuous record, Series "E" charts are marked with the number of feet remaining at every 12 inches on the chart in the right hand margin. When 10 feet of chart remain, a note on the chart so indicates. When only three feet of chart is left, "THE END" is clearly printed across the chart.

Always keep enough Esterline Angus charts on hand to operate the recorder for at least one month. By purchasing in quantities, savings can be realized. Charts must be ordered by assigned numbers, which are printed every six inches on the margin of the chart.

SECTION III - MAINTENANCE

GENERAL

The Chart Drive module employed in this recorder is of sturdy construction and is designed for long trouble-free operation. Nevertheless, it should receive the care afforded any precision piece of equipment to extend its useful life. Periodic maintenance schedules should be established and followed to insure optimum performance of the instrument. These schedules should include inspection, cleaning, adjustments, and lubrication. Time intervals between regularly scheduled maintenance operations will vary according to the frequency of use and environmental conditions. Maintenance scheduling is therefore left entirely up to the discretion of the user. Where extreme temperatures or contaminated atmospheres prevail, the user should adopt a more frequent schedule.

WARNING

To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

It will usually be desirable to remove the front panel from the chart drive module to facilitate inspection and lubrication of the drive components. To remove panel, simply remove all control knobs by loosening set screws and remove hex nuts from switches, then remove two screws at each side of panel and lift it off.

INSPECTION

A complete visual inspection of the chart drive should be made at each maintenance period in order to detect the possible onset of a malfunction. Particular attention should be paid to the following:

1. Accumulation of dirt or other foreign bodies within the mechanism.

2. Loose screws, couplings, nuts and other hardware.

3. Misalignment of gears, shafts, arms, etc.

4. Evidence of excessive wear in moving parts.

5. Damaged wiring and loose connections.

6. Missing or damaged tensioning springs (ET-321 and ET-327 only).

If a fault is evident from any of the above possible troubles, proper corrective measures should be instituted without delay.

CLEANING

Dirt, dust, or other foreign bodies are not conducive to long life of working parts, and precautions should be taken to prevent admission of these substances into the chart drive assemblies. Regardless of the precautions taken, dirt will enter the case and therefore the chart drive should be cleaned periodically.

Remove chart paper, roller cylinders, cover plates, and front control panel before cleaning. All surfaces should be carefully cleaned using a soft bristled brush or low vacuum system. Mild soap or detergent may be used to clean the writing table, control panel and to wipe off the outer surfaces of the roller cylinders.

CAUTION

Do not disturb mechanical alignment of parts or routing of wiring during cleaning procedures.

Ink or other liquids, if spilled on the chart drive mechanism, should be removed promptly with appropriate means. EA recording ink is is water-based and may be removed with a wet cloth. Other liquids must be removed by means appropriate to their nature. Dirt may be removed, especially when lodged in lubricating grease, by use of a suitable brush and a mild solvent--such as benzine. Harsh solvents, such as acetone or paint brush reconditioners, should not be employed because of possible damage to plastics. When a solvent has been used, parts should be allowed to dry thoroughly before a lubricant is applied.

CAUTION

Do not use excessive amounts of cleaning solvents on oil impregnated bearings.

ADJUSTMENTS

Although all Esterline Angus chart drives are carefully adjusted for high standards of operation before leaving the factory, the following field adjustments are made possible to satisfy special applications and as a preventive maintenance measure.

CHART TENSION -- For optimum chart drive operation the chart paper must have a regulated amount of tension applied to it at all times; the paper must not be too loose so that it sags, and it must not be drawn too tight so that it wrinkles or tears. The drive roll propels the paper at an accurate rate of speed while proper tension is maintained by two separate clutch assemblies; one in the reroll cylinder and one in the supply roll cylinder. These clutches are adjusted as follows:

CAUTION

Do not attempt to adjust clutches unless trouble has been traced to this possible source.

Remove the reroll cylinder from the chart transport, tighten (6-32 hex-socket) set screw into the cylinder at its geared end, and withdraw the end flange assembly (see Figure 2-19). Adjust clutch tension by turning the adjusting nut in the direction required.

If clutch tension is too great, the chart paper may start to wrinkle as it leaves the drive roll. In extreme cases, the paper may even tear at the back edge of the drive roll pins. If there is not enough tension, the paper may tend to sag and not wrap properly on the reroll cylinder.

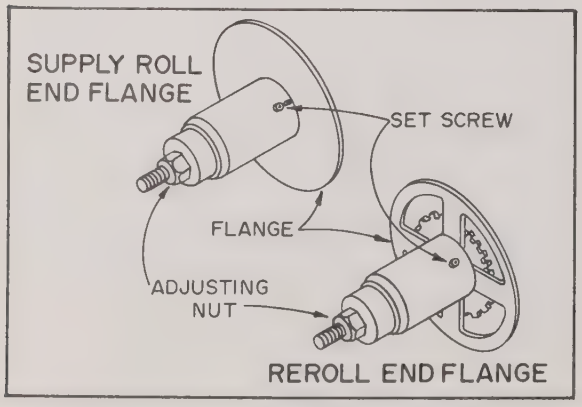


FIGURE 2-19. End Flange Assembly Showing Paper Tension Adjustment.

These conditions will not exist when the reroll clutch is correctly adjusted. After proper tension is achieved, replace the flange assembly and check operation.

Remove the supply roll cylinder from the transport, turn-in set screw, and withdraw the end flange assembly from the keyed end of the cylinder. Adjust clutch tension by turning the adjusting nut in the direction required (Figure 2-19).

If clutch "drag" tension is too great, the chart paper may tend to tear at the leading edges of the drive roll pins. If tension is too little, the paper may not lay flat across the top of the drive roll and, in some cases, the paper may even skip over the drive-roll pins. These conditions will not exist when the supply roll clutch is correctly adjusted. After proper tension is achieved, replace the flange assembly and check operation.

CHART WEAVE -- For optimum chart drive operation, lateral movement of the drive roll must be limited in order to keep the chart paper from weaving from side-to-side. Although this "end-shake" adjustment has been precisely set at the factory, readjustment may become necessary in the field if the drive-roll set screw has been inadvertently loosened or undue force has been exerted upon either the roll or its manual adjust knob.

If end shake is too great, the roller will drift back and forth during operation and cause the paper to weave. If the adjustment is set too tight, the roller will not turn freely -- thus placing an excessive load upon the driving source. Drive roll end shake is adjusted as follows:

1. Open case door, turn off power, slide out chassis to its service position, and tilt down chart drive.

2. Loosen (6-32 hex-socket) set screw on right-hand end of drive roll. See Figure 2-20.

NOTE: If difficulty is encountered when loosening set screw, the screw may be secured with a sealant. Heat screw with tip of soldering tool and free while warm.

3. Holding drive roll firmly against left-hand sideplate, pull drive roll knob outward until retaining ring on knob shaft seats against inner bearing surface of right-hand sideplate.

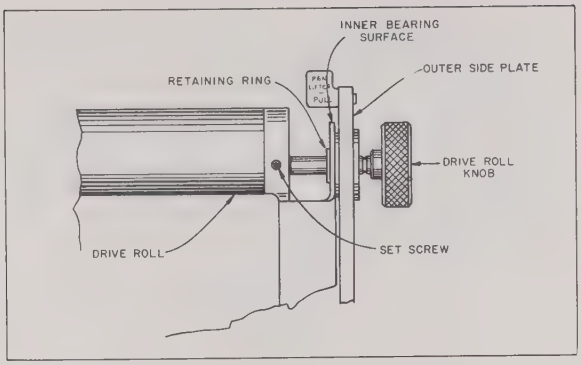


FIGURE 2-20. Part Of Transport Assembly Showing End-Shake Adjustment.

4. Carefully tap knob inward until a clearance of approximately .0005" to .002" is obtained between shaft retaining ring and inner bearing surface.

NOTE: A thin piece of paper may be used as a shim gauge for this operation.

5. Tighten drive roll set screw against knob shaft and check operation.

LUBRICATION

The chart drive mechanism should be lubricated at regularly scheduled intervals, but only with lubricants recommended in this manual. Always clean the part or assembly before lubricating. DO NOT OVER LUBRICATE -- always wipe off excessive oil and grease before exposing the instrument to dirt laden atmospheres.

Lubrication points are shown in Figure 2-21. Under normal operating conditions bearing shafts and clips of rollers, the transport latch, and all pivot points should be oiled once every six months. All gear teeth should be greased once every 12 months. The bronze bearings which are pressed into the sideplates of the various assemblies are oil impregnated and will require little lubrication. If cleaning solvents are used, however, these bearings should be relubricated once every 15 to 18 months.

The reversible synchronous motor may be oiled through small holes in its case; these holes are accessible by tilting the drive downward and removing the plastic plugs from the top of the drive module plate (Figure 2-21). Add four drops of oil to each red hole in motor after initial installation. For normal duty (8 hours/day, 5-day week) relubricate the red holes with 10 drops of oil every six months, or more frequently if ambient temperatures remain above 104° F. For more continuous duty add oil after every 2000 running hours. Lubricate the yellow hole in the motor with 20 drops of oil every three months for normal duty (8 hours/day, 5-day week).

The synchronous motor employed for the faster, second chart speeds (drive ET-327) is permanently lubricated at the factory and will not require further attention in the field.

Recommended oil lubricants are as follows:

Stanoil #35 (Manufactured by Standard Oil-Div. Americal Oil Company) or equivalent.

Gulf Harmony 53 (manufactured by Gulf Oil Co.) or equivalent.

Recommended grease lubricants are as follows:

Beacon 325 (manufactured by Humble Oil Co.) or equivalent.

DISASSEMBLY

ASSEMBLY REMOVAL -- To remove the entire transport and drive module from the instrument chassis, proceed as follows:

WARNING
Always disconnect power from the instrument before disassembly or servicing.

1. Remove external power connections from rear of recorder.

2. Open case door and pull chassis out to its service position.

NOTE: If desired, the entire chassis may be removed from the case as directed in Part 3, Section III under DISASSEMBLY.

3. Tilt down chart transport and remove one support bracket (at either side) by removing three screws, and slide the transport out of the other bracket.

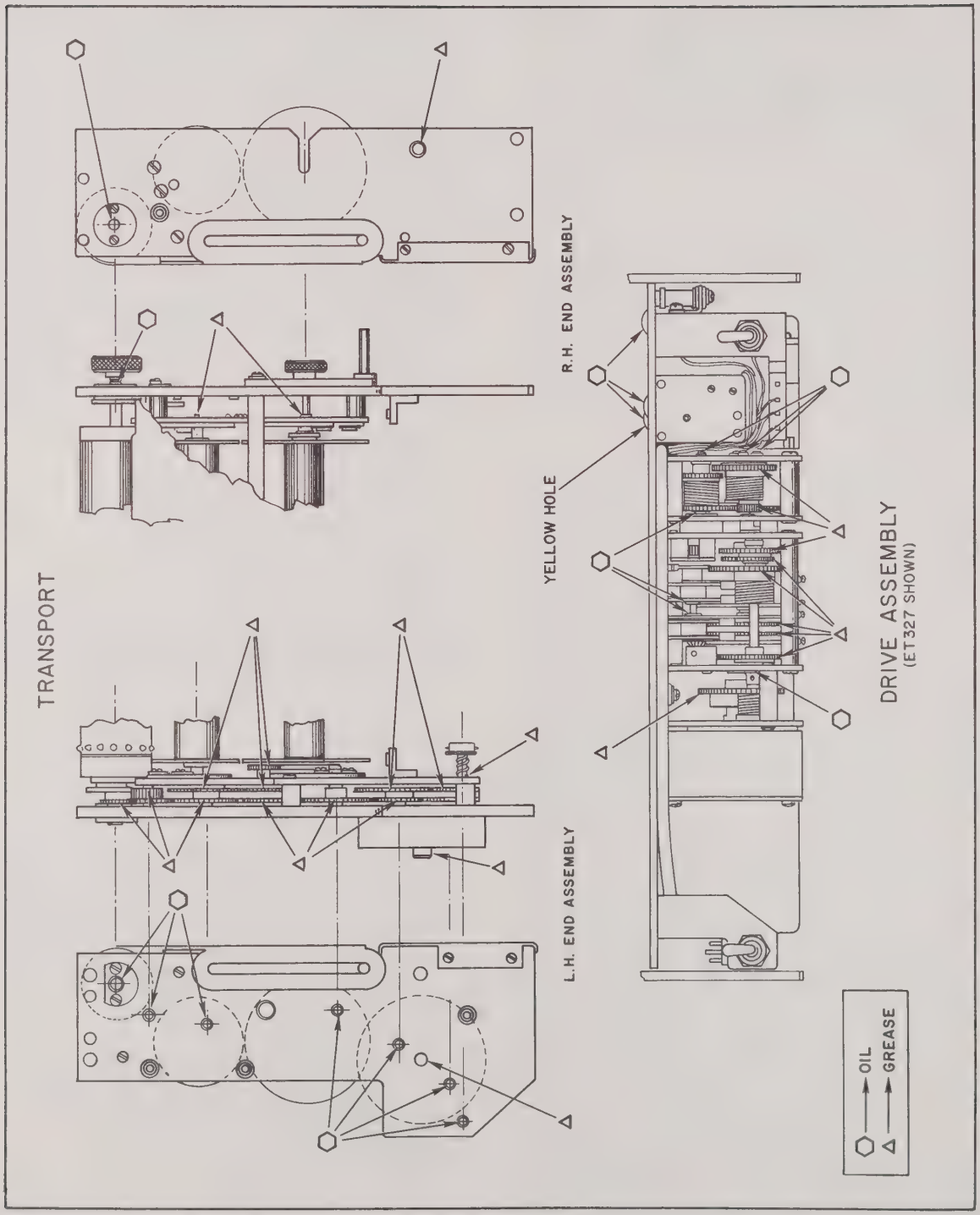


FIGURE 2-21. Lubrication Points for Series "E" Chart Drives.

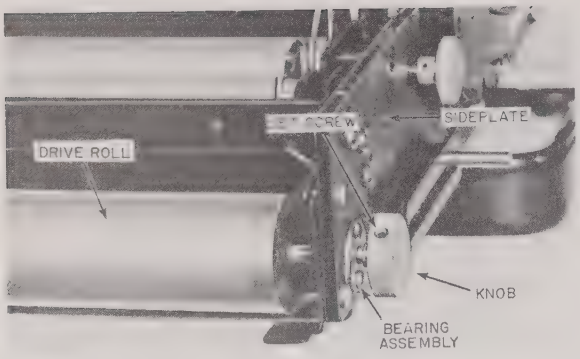


FIGURE 2-22. Drive Roll, Knob And Removable Bearing.

DRIVE ROLL -- To remove the drive roll from the transport assembly, refer to Figure 2-22 and proceed with the following steps:

1. Loosen (8-32 slotted) set screw in drive roll knob and pull knob from end of shaft.

2. Remove two screws securing bearing assembly to side plate and remove bearing.

3. Carefully slide drive roll shaft into bearing hole until geared end of roll is free and may be raised up and out.

CAUTION

Do not damage drive roll pins.

4. After geared end of roll is free, pull bearing end from hole in sideplate and remove entire assembly.

CONTROL PANEL -- The front control panel for the chart drive may be removed as follows:

1. Loosen set screws in front panel knobs and remove knobs.

2. Remove knurled switch-retaining nuts from front panel.

3. Remove two machine screws from each end of control panel.

4. Remove panel by pulling straight forward.

DRIVE MODULE -- To remove the chart drive module, it is first necessary to remove the entire transport assembly from the chassis, since the mounting screws are inaccessible when the transport is in place.

WARNING

Always disconnect power from the instrument before disassembly or any service operation.

1. Remove the entire transport and drive module as directed under ASSEMBLY REMOVAL in this Section.

2. Remove one chart drive support bracket (at either side) by removing the three screws from the chassis sideplate and slide the transport assembly out of the other bracket. Do not lose the rubber inserts from the tilt retarder at the left side of the transport assembly.

3. Loosen the (No. 4-40 hex socket) set screws in both couplings on the output shaft and slide couplings toward each other. Remove the output shaft (see Figure 2-23).

NOTE: If difficulty is encountered when loosening set screws, it may be caused by the use of a sealant. Heat screws with tip of a soldering iron and loosen while still warm.

4. Remove the four drive-module mounting screws (two at each end) which attach the module to the brackets on the transport assembly (Figure 2-23).

CAUTION

Support the reversible motor when the mounting screws are removed from end of motor.

5. Remove the entire drive module from the base of the transport assembly.

MOTOR-TRANSMISSION -- The motor-transmission assembly may be removed from the drive module by referring to Figure 2-23 and proceeding with the following steps:

1. Remove entire drive module from chart drive assembly (see instructions).

2. Remove cover(s) from terminal strip(s) on drive module and unsolder motor leads.

3. Remove two transmission mounting screws pointed out in Figure 2-23.

4. Carefully remove motor-transmission assembly from mounting plate.

DRIVE MOTORS -- The chart drive motor or motors may be removed from the motor-transmission assembly by referring to Figure 2-23 and proceeding with the following steps:

1. Remove entire drive module from chart drive assembly (see instructions).

2. Remove motor-transmission assembly from drive module (see instructions).

3. Loosen (6-32 hex-socket) set screw in pinion of motor shaft.

4. Remove two motor mounting screws from side plate of gear box or transmission.

5. Carefully slide motor shaft and pinion assembly out of geared unit.

REPLACEMENT PARTS

All parts for Series "E" chart drives are made available directly from Esterline Angus. When ordering parts, always give part numbers and instrument serial number. Refer to the illustrated parts breakdown in this manual for parts identification.

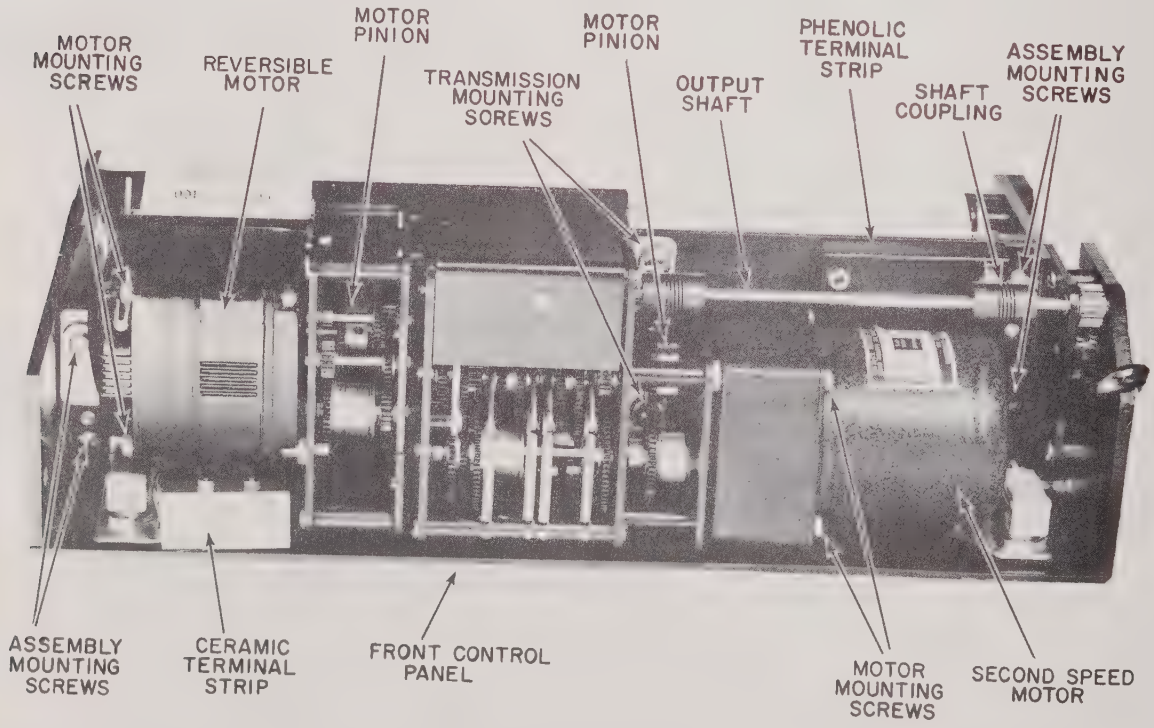


FIGURE 2-23. Complete ET-327 Drive Module Showing Disassembly Points.

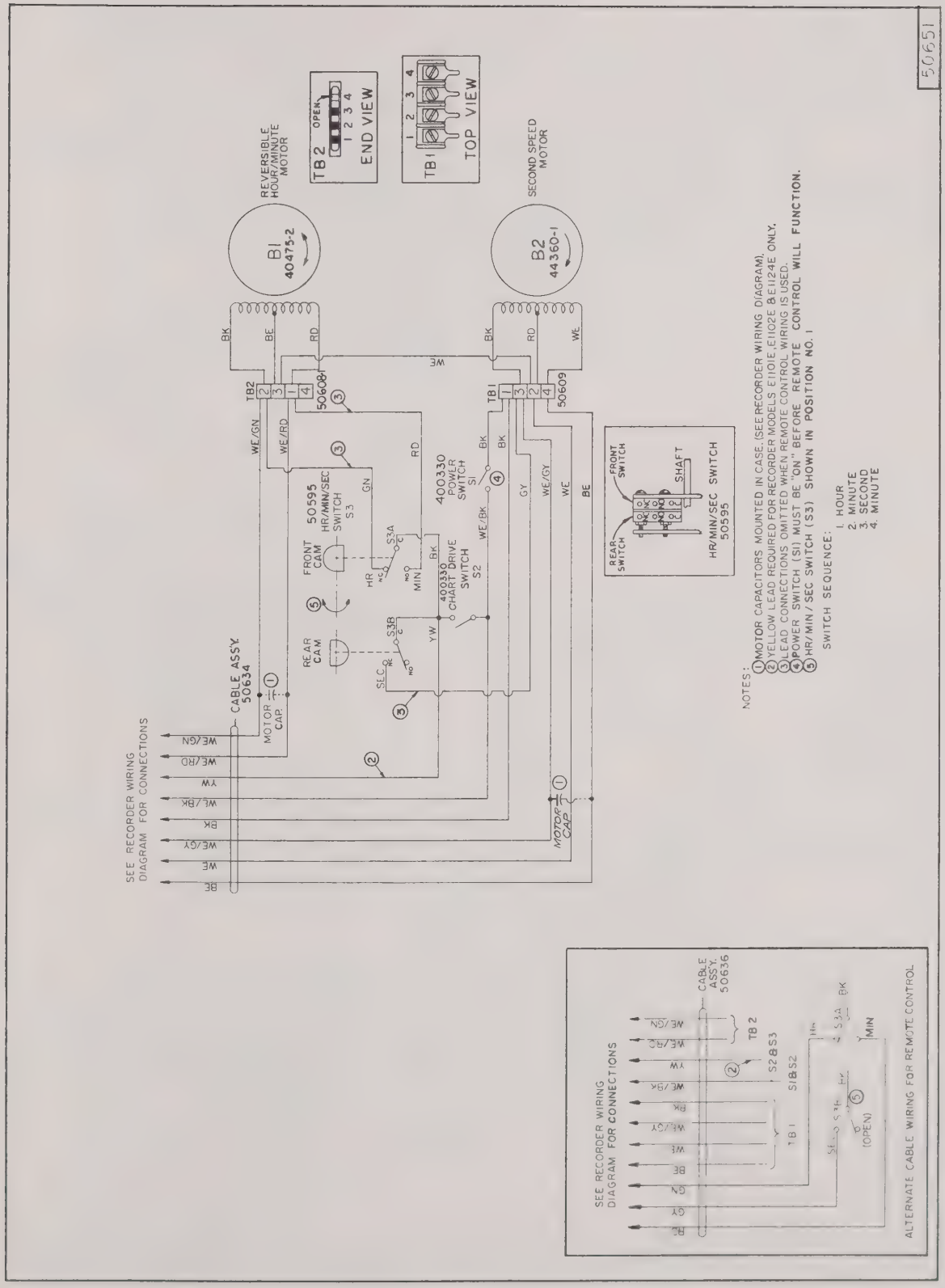


FIGURE 2-24. Power Wiring Diagram for Chart Drive No. ET-327.

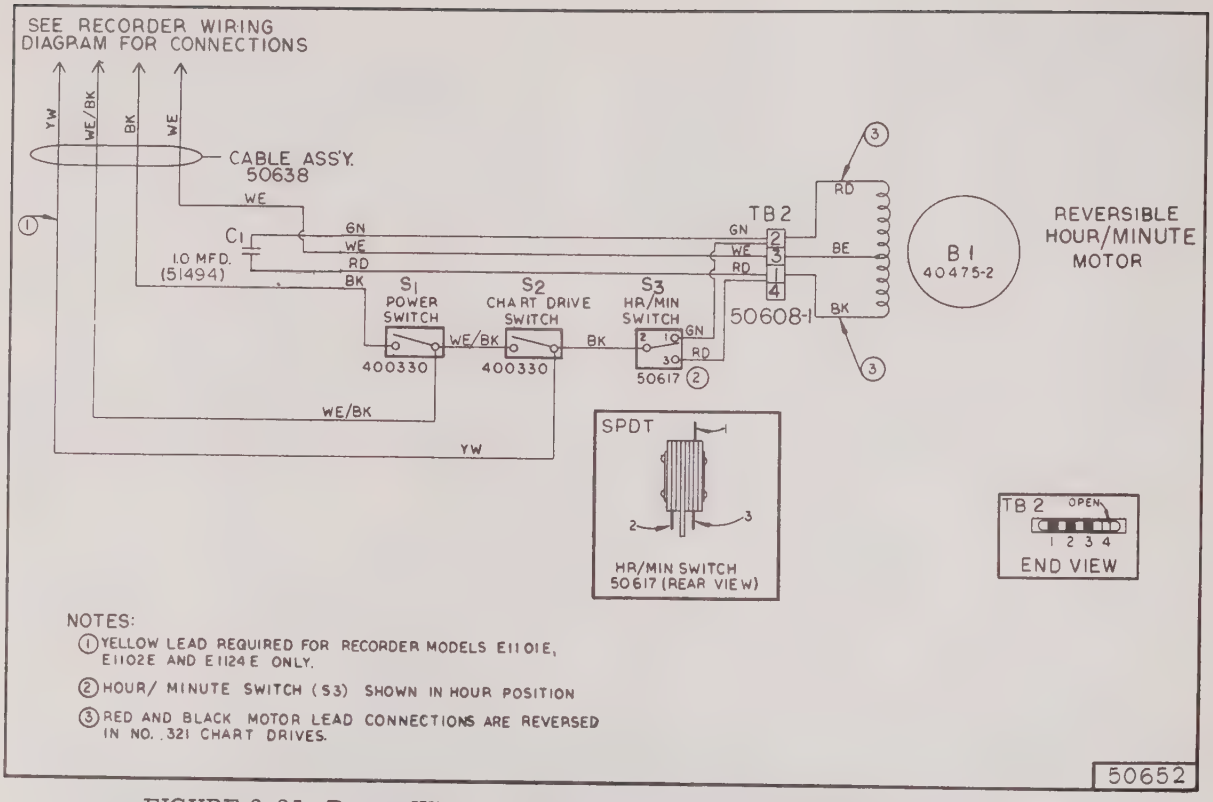


FIGURE 2-25. Power Wiring Diagram for ET-318 and ET-321 Chart Drives.

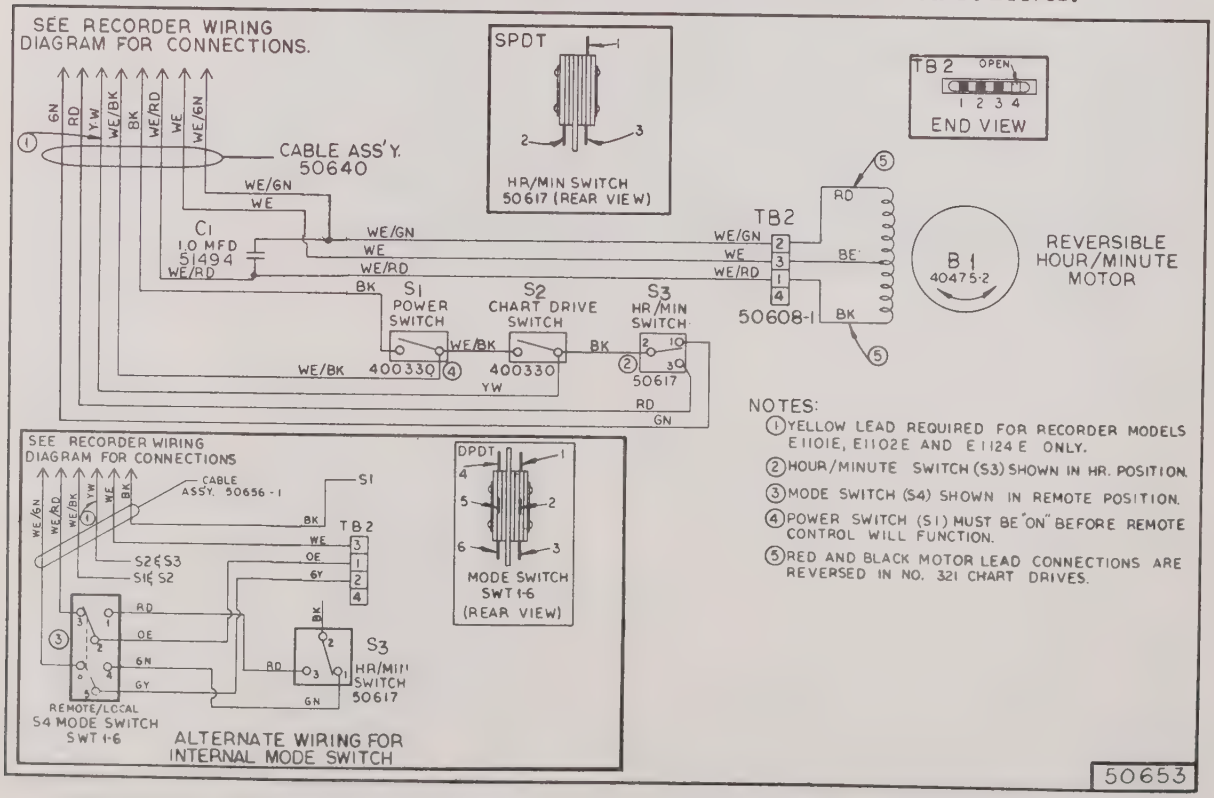

SEE RECORDER WIRING DIAGRAM FOR CONNECTIONS.
SPDT
HR/MIN SWITCH 50617 (REAR VIEW)
TB2 OPEN
1 2 3 4
END VIEW
CABLE ASS'Y. 50640
C1 1.0 MFD 51494
S1 POWER SWITCH
S2 CHART DRIVE SWITCH
S3 HR/MIN SWITCH
400330
400330
50617
50608-1
TB2
B1 40475-2
REVERSIBLE HOUR/MINUTE MOTOR
NOTES:
1 YELLOW LEAD REQUIRED FOR RECORDER MODELS E1101E, E1102E AND E1124E ONLY.
2 HOUR/MINUTE SWITCH (S3) SHOWN IN HR. POSITION.
3 MODE SWITCH (S4) SHOWN IN REMOTE POSITION.
4 POWER SWITCH (S1) MUST BE "ON" BEFORE REMOTE CONTROL WILL FUNCTION.
5 RED AND BLACK MOTOR LEAD CONNECTIONS ARE REVERSED IN NO. 321 CHART DRIVES.
SEE RECORDER WIRING DIAGRAM FOR CONNECTIONS
CABLE ASSY. 50656-1
DPDT
MODE SWITCH SWT 1-6 (REAR VIEW)
REMOTE/LOCAL S4 MODE SWITCH SWT 1-6
ALTERNATE WIRING FOR INTERNAL MODE SWITCH
50653

FIGURE 2-26. Power Wiring Diagram for ET-318 and ET-321 drives with remote control.

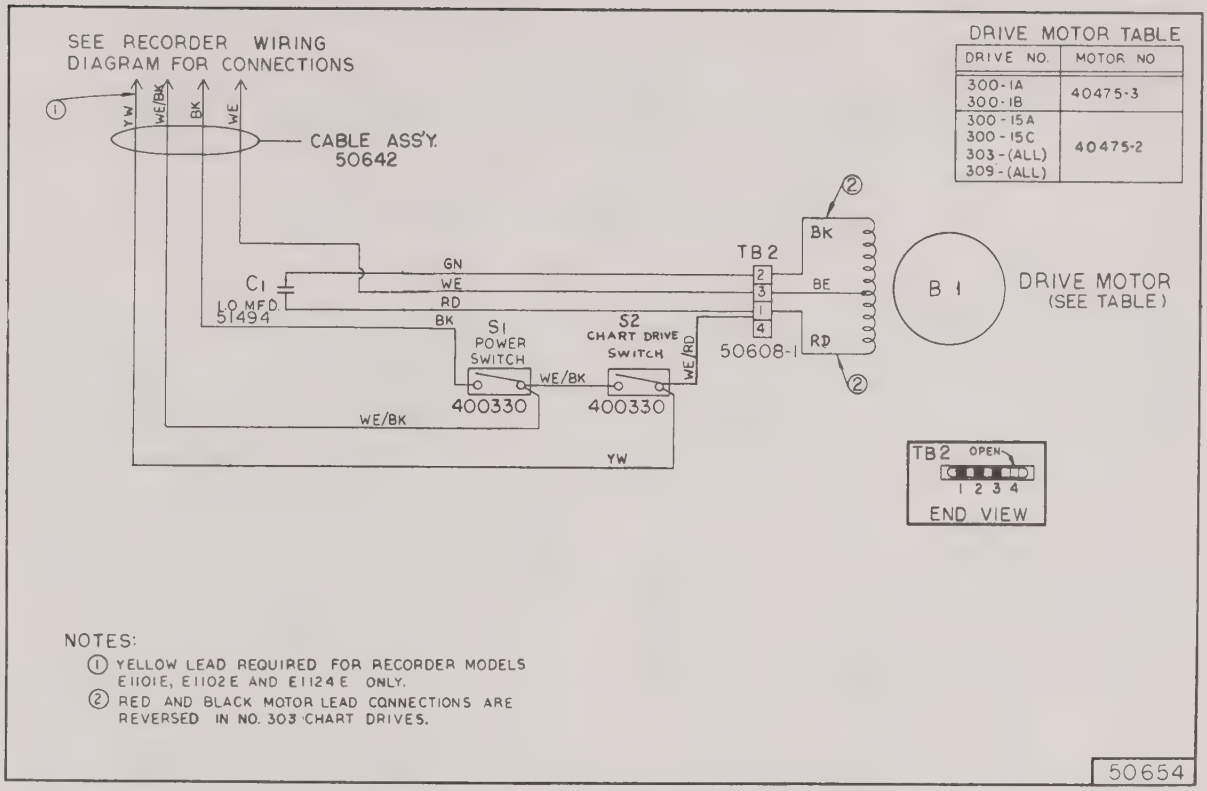


FIGURE 2-27. Power Wiring Diagram for ET-300, ET-303 and ET-309 Chart Drives.

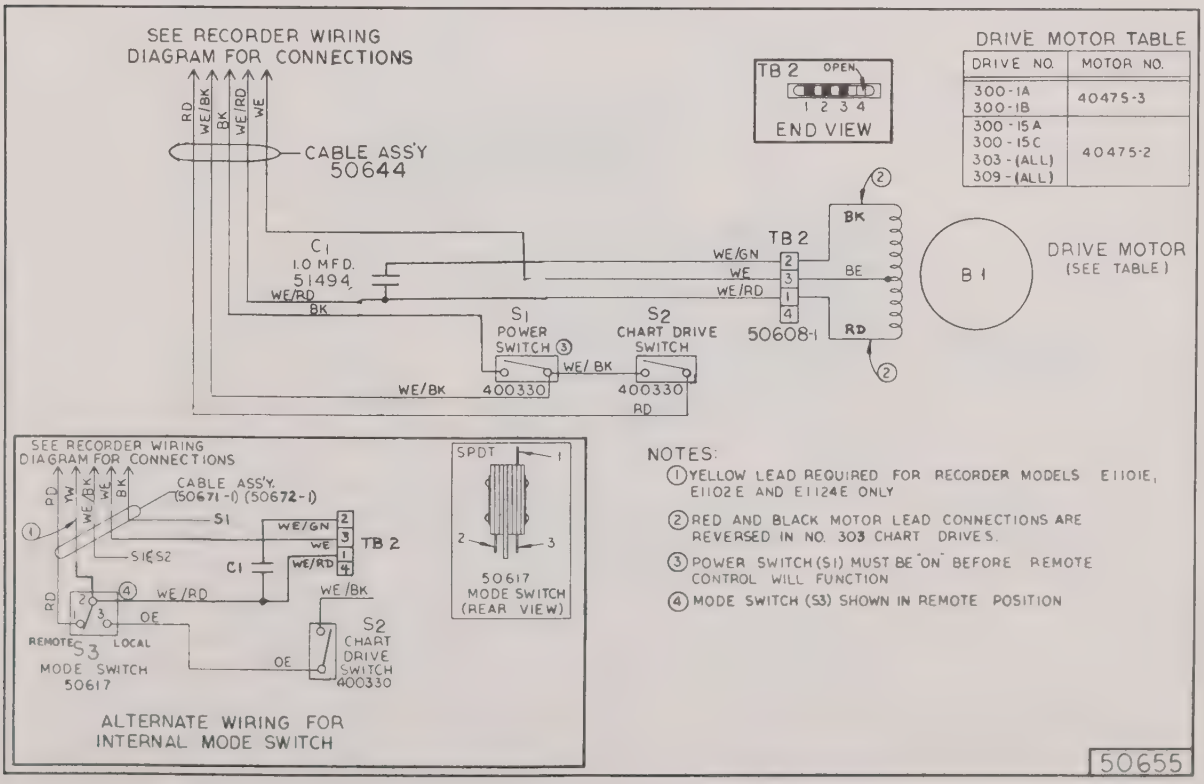


FIGURE 2-28. Power Wiring Diagram for ET-300, ET-303 and ET-309 Chart Drives With Remote Control.

PART 3
MEASURING SYSTEM

SECTION I - DESCRIPTION

GENERAL

This part of the instruction manual covers the operation and maintenance of the measuring circuits and inking components employed in Models E1102R and E1104R RectiGRAPH recorders. These instruments are designed to graphically record multiple analog information on wide 11" strip charts having either two or four side-by-side channels. A pen-and-ink system is employed as a method of writing for each channel. Two constant-head refillable inkwells are included, with each having a large one-ounce capacity. All chart spans have rectilinear coordinates and will normally be linearly calibrated. The chart paper is propelled at a certain speed, or variety of speeds, depending upon the style of synchronous drive selected. See PART 2 for specific chart drive information.

Several different internal measuring systems are offered as options in these recorders. Standard systems include: DC Milliammeters and Microammeters, DC Voltmeters and Millivoltmeters, AC Ammeters and Voltmeters, as well as AC and DC Expanded Scale Voltmeters. Multipurpose or Multirange systems are also available upon special order.

The internal measuring systems contain only precision components of rugged construction to insure the utmost in both accuracy and reliability. An exclusive feature of all RectiGRAPH recorders is the motion translator which converts rotating motion of the moving coil into straight-line (rectilinear) motion.

All recorder components including the chart drive mechanism are mounted on a rigid slide-

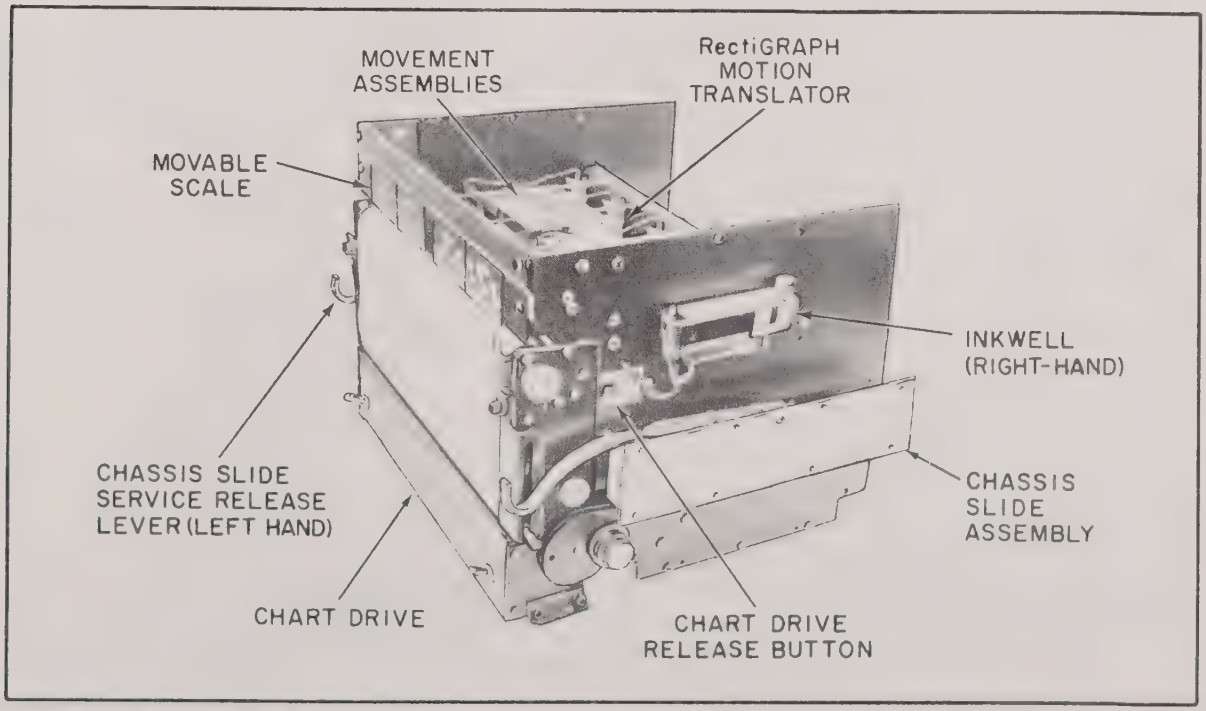


FIGURE 3-1. RectiGRAPH® Chassis Removed from Case.

TABLE 3-1.

STANDARD SPECIFICATIONS

ACCURACY

AC Volts, AC Milliamperes or Amperes. ..... 2% of full scale (sine wave applied).
DC Microamperes, DC Millivolts or Volts ..... 2% of full scale.
DC Volts (1,000 ohms/volt) or Milliamperes ..... 1% of full scale.

RESPONSE

Approximately 1/2 second to record 99% of final value, when critically damped. Response is independent of pen amplitude excursion.

TEMPERATURE LIMITS -- Recommended ambient temperature range of from ±20°F to ±120°F for specified operation.

ZERO CALIBRATION -- DC instruments can be provided with choice of left-hand, center, or right-hand zero, which may be shifted with slight loss of accuracy. AC instruments can be provided with either left-hand or right-hand zero.

MEASURING SYSTEMS

Measurement	MODEL E1102R			MODEL E1104R		
	Basic Range ±	Nominal Input Resistance (Ohms)	Source Resistance For Critical*** Damping (Ohms)	Basic Range ±	Nominal Input Resistance (Ohms)	Source Resistance For Critical*** Damping (Ohms)
DC Microamperes or Milliamperes	0-10 μA*	1,000	1,000 Min.	0-10 μA*	1,000	1,000 Min.
	0-1 MA	1,400**	Any resistance**	0-1 MA	1,250	35,000
	0-2 MA	1,400	40,000	0-2 MA	650	25,000
	0-5 MA	260	2,000	0-5 MA	75	3,000
	0-15 MA	95	300	0-15 MA	9.8	300
	0-45 MA	3.2	41	0-45 MA	1.3	12

± Higher and intermediate ranges can be obtained by shunting.
*Uses magnetic amplifier. Requires additional 2 VA at 120 V, 50-60 Hz. Available for ratings of 12 V DC or 120 V, 400 Hz.
**Value accomplished by using impedance matching amplifier. Response is about 1/2 second and is completely independent of external circuit characteristics. Instrument also available without amplifier; in which case input resistance is 5,800 ohms, and source resistance for critical damping is 100,000 ohms.
***Critical damping permits writing element to move from one equilibrium position to another in the shortest possible time with minimum overshoot.

Measurement	MODEL E1102R			MODEL E1104R		
	Sensitivity (Ohms/Volt)	Ranges		Sensitivity (Ohms/Volt)	Ranges	
		Minimum	Maximum		Minimum	Maximum
DC Millivolts or Volts	100,000	0-10 MV*	0-50 V	100,000	0-10 MV*	0-50 V
	1,000	0-2 V***	0-600 V **	1,000	0-2 V***	0-600 V**

*Uses magnetic amplifier. Requires additional 2 VA at 120 V, 50-60 Hz. Available for ratings of 12 V DC or 120 V, 400 Hz.
**Ranges up to 0-1,500 V can be provided by using a separate potential divider.
***On ranges below 25 V DC for E1102R and below 7 V DC for E1104R recorders, an impedance matching amplifier is used to insure 1/2 second response.

Measurement	MODELS E1102R and E1104R		
	Basic Range ±	Frequency Limits* (HZ.)	
AC Milliamperes or Amperes	0-5 MA	60	±Intermediate and multiple ranges can be provided.
	0-50 MA**	50-3,000	*By calibrating an instrument for specific frequency, amperes can be accurately recorded in circuits up to 10,000 Hz.
	0-1 A	50-3,000	
	0-2.5 A	50-3,000	**The 50 MA range is for use with a split-core current transformer with a 50 MA secondary.
	0-5 A	50-3,000	
	0-10 A	50-3,000	

Measurement	MODELS E1102R and E1104R				
	Sensitivity (Ohms/Volt)	Ranges		Frequency Limits(Hz.)	
		Minimum	Maximum		
AC Volts	455(Max.)	0-50	0-600*	50-3,000**	*Ranges 0-1,500 V AC can be obtained by using a separate potential divider. **By calibrating an instrument for a specific frequency, volts can be accurately recorded in circuits up to 10,000 Hz.

out chassis as shown in Figure 3-1. For the specific type of measuring elements employed in your recorder, refer to the Data Sheet found at the back of this manual.

MEASURING ELEMENTS

Each channel of the recorder incorporates a galvanometric meter movement. This permanent-magnet, moving-coil assembly consists of an armature coil suspended in a fixed magnetic field which is formed by two U-shaped magnets. The armature coil is wound on a metal frame which is supported at both ends by jeweled pivots so that it is free to turn.

As current flows in the armature, an electromagnetic field is developed around the coil; this field automatically attempts to move itself out of the fixed field, torque is generated, and the armature turns on its axis. Rotation of the coil is opposed by a pair of counter-wound spiral springs which are connected to the lower part of the armature staff. These springs return the coil to a fixed zero position when no current is flowing. The degree of rotation depends directly upon the magnitude of current flowing in the armature coil.

In addition, the movement has an inherent damping characteristic resulting from eddy currents induced in the moving-coil frame. These currents produce a "bucking" magnetic field that tends to minimize overshoot and oscillation.

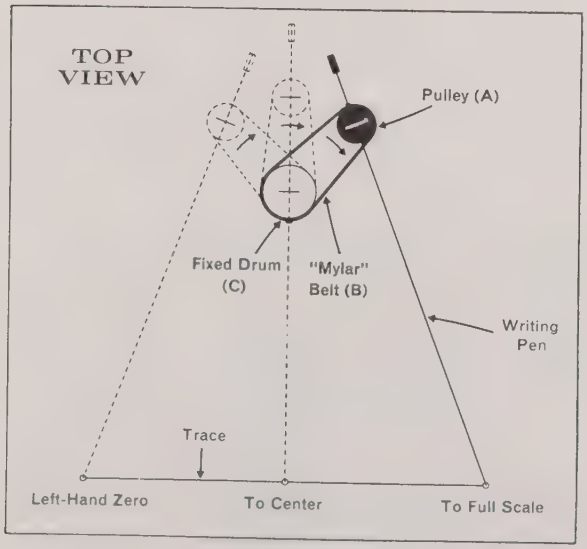


FIGURE 3-2. Operational Diagram Of Rectilinear Motion Translator Mechanism.

Rotating motion of the armature coil is converted to rectilinear recordings through the use of a special motion translator (See Figure 3-2 below). This all-mechanical device actuates the writing pen without use of gears, slidewires, or long dial cables.

As shown in Figure 3-2, the driving shaft of the meter movement (which is concentric with stationary drum C) swings pivotal pulley A in an arc shown by the small curved arrows. Belt B is affixed to one point on pulley A and to one point on drum C. As pulley A swings to either side, the belt wraps around drum C which, in turn, rotates pulley A on its central pivot. With the writing pen attached to pulley A, the geometry of the system causes the pen to trace a straight line across the chart at a rate that is constant with respect to the rotation of the movement armature.

GENERAL APPLICATIONS

Any analog data represented by electrical signals within metering range of the instrument may be recorded on the Model E1102R or Model E1104R. Electrical signals that are outside the range limits of these instruments may also be recorded by using signal-conditioning devices--such as current or potential transformers, shunts, resistance multipliers, rectifier networks, and amplifiers. Many types of transducers may be used with the instrument to convert various phenomena into useful analog signals. For additional information, consult your local sales representative or the Customer Service Department of Esterline Angus.

In applications where it is suspected that a recorder might upset the operation of an electrical circuit, the loading effect should be tested prior to the permanent installation of the instrument. This may be accomplished by connecting an indicating meter in place of the recorder, together with enough series or shunt resistance so that the total resistance of the test network equals that of the recorder under consideration. If this test network upsets the circuit or the measured readings are too low to be useful, an Esterline Angus recorder with greater sensitivity is recommended.

In most applications it will be desirable for the recording pen to move from one scale position on the chart to another in the shortest possible time, yet with no appreciable overshoot.

Such a condition is normally referred to as "critical damping". A precise amount of damping has been designed into each galvanometric movement employed in these RECTIGraph recorders; and therefore, response speed of the pen will not normally be affected by characteristics of the circuit in which the recorder is operated. In the more sensitive instruments, however, damping and consequently response speed will vary considerably with external circuit resistance. When a movement is critically damped through the proper selection of circuit resistance, full-scale response time will be approximately 1/2 second. Consult Table 3-1 for additional information on source and input resistance.

If maximum response speed is desired so that the movement responds to rapid changes in the measured quantity, the recorder should be operated in a circuit of the highest possible resistance. Under these conditions, however, transients will usually cause pronounced overshoots. If a slow response is desired so as to produce an average measurement unaffected by short-period changes, the recorder should be operated in a low-resistance circuit.

SECTION II - OPERATION

Do not attempt to put this instrument into operation until all instructions have been thoroughly studied. Failure to make proper connections or to make necessary checks and adjustments may result in unsatisfactory operation or damage to the instrument.

SLIDE-OUT CHASSIS

The entire recorder chassis mounts on special slide tracks so that it may be easily pulled forward and locked in a service position, which provides the operator convenient access to adjustments and internal components.

To slide out the chassis to its service position, open the case door, release the lever on each slide track, and pull the chassis forward until it reaches the slide stops. All systems are operational with the chassis in this extended position.

The entire chassis may be removed from the case, if necessary, as directed in Section III under DISASSEMBLY.

ELECTRICAL CONNECTIONS

Before making any electrical connections, refer to the connection diagram, Figure 3-3, and to the Terminal Code Plate found on the rear of the instrument case. The code plate identifies all connection points and specifies electrical input ratings. Internal wiring is terminated at the terminal blocks within the recessed compartment on the back of the case. Input terminal connections are made accessible by removing eight screws securing the rear cover plate. Each rear panel terminal is identified by a number, and this number will appear on the code plate when used as a function of the instrument.

Figure 3-3 illustrates the rear panel of the E1102R and E1104R recorders. The number of signal input terminals supplied will depend upon the Model ordered (4 for E1102R and 8 for E1104R). Terminal block TB202 is supplied only when accessories which require its use are ordered. This diagram, in conjunction with the other diagrams in this manual, provides complete information for all standard electrical connections. If special modifications are ordered additional connection information will be supplied in the appendix of the manual.

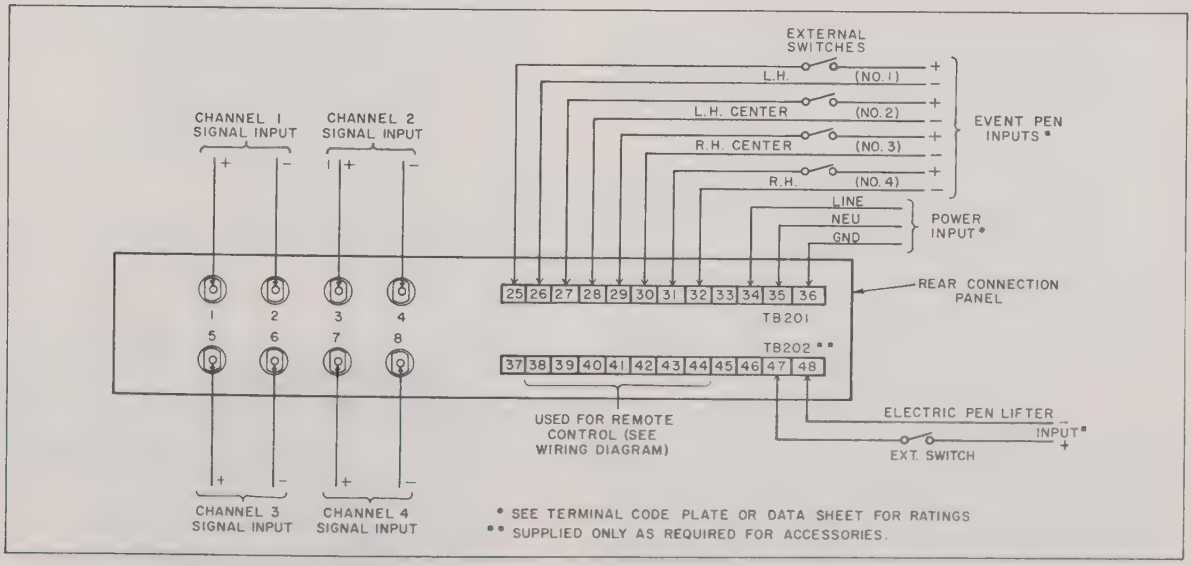

EXTERNAL SWITCHES
L.H. (NO. 1)
L.H. CENTER (NO. 2)
R.H. CENTER (NO. 3)
R.H. (NO. 4)
EVENT PEN INPUTS *
LINE
NEU
GND
POWER INPUT *
CHANNEL 1 SIGNAL INPUT
CHANNEL 2 SIGNAL INPUT
CHANNEL 3 SIGNAL INPUT
CHANNEL 4 SIGNAL INPUT
1 2 3 4
5 6 7 8
25 26 27 28 29 30 31 32 33 34 35 36
TB201
REAR CONNECTION PANEL
TB202 **
37 38 39 40 41 42 43 44 45 46 47 48
USED FOR REMOTE CONTROL (SEE WIRING DIAGRAM)
ELECTRIC PEN LIFTER INPUT *
EXT. SWITCH
* SEE TERMINAL CODE PLATE OR DATA SHEET FOR RATINGS
** SUPPLIED ONLY AS REQUIRED FOR ACCESSORIES.

FIGURE 3-3. External Connection Diagram for E1102R and E1104R Recorders.

Access holes are provided in the sides and bottom of the case for entrance of external wiring. If conduit is not used, remove the plug buttons from the holes required and insert the rubber grommets supplied.

If the recorder is to be operated in a circuit with other instruments, Esterline Angus will provide information for recommended connections upon request. Care must be taken to connect current circuits in series and potential circuits in parallel. Refer to the Data Sheet for any electrical ratings not given on the Terminal Code Plate.

INKING INSTRUCTIONS

Each channel of this recorder employs Esterline Angus graphic ink to produce a permanent record on the chart paper. This writing fluid is especially formulated to satisfy the exacting requirements of recording instruments; therefore, no other substitute should be used.

The recorder is shipped with the inking systems in a dry state. As part of putting the instrument in operating condition, the pen elements must be installed, the inkwells filled with ink, and each system primed in accordance with the instructions that follow.

Prior to making each inking system operational, a new chart should be installed by following steps given in the charting instructions; and see that all shipping materials have been removed from the case and chassis.

Unpack accessory kit (including the following):
- 2 Two ounce bottles of ink (colors optional)
- 2 Inkwell filler syringes
- 2 Primer and flusher syringes
- 2 Pen point cleaners

Install pens and prepare inking system as follows:

(a) Slide the chassis out to its service position. Remove the pen element (for each channel) from the packing box and seat the knife-edge pivot between the fork assembly of the meter movement. Note that, when properly seated, the pen is free to move in a vertical direction, but has no free play from side to side (Figure 3-4).

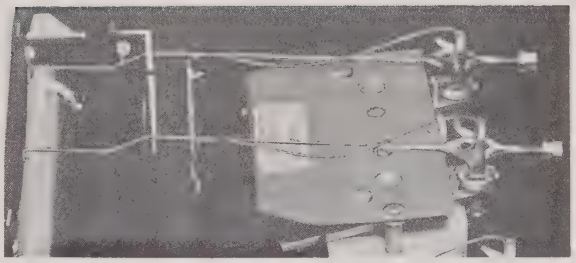


FIGURE 3-4. Installation of Pen Elements.

CAUTION

The pen staff has a specific configuration which is necessary for proper recording. Handle pen elements with care at all times. NEVER bend the pen for adjustment or in an attempt to improve its performance.

(b) Free the flexible ink hose from all twists and carefully fit it over the metal feed tube protruding from the rear of the chassis bracket. Approximately 1/8-inch is sufficient to insure a good seal. Make sure that the tube is relaxed and does not exert any torque on the pen assembly.

(c) Repeat the above procedure for the remaining pen, or pens, attaching the ink hose of each pen assembly to the nearest metal feed tube. Inspect the ink tubing from the chassis brackets to the inkwells, making sure that they are firmly attached at both ends and are not kinked or pinched at any point.

(d) To fill the inkwells on the sides of the chassis, first push the vent pin downward to

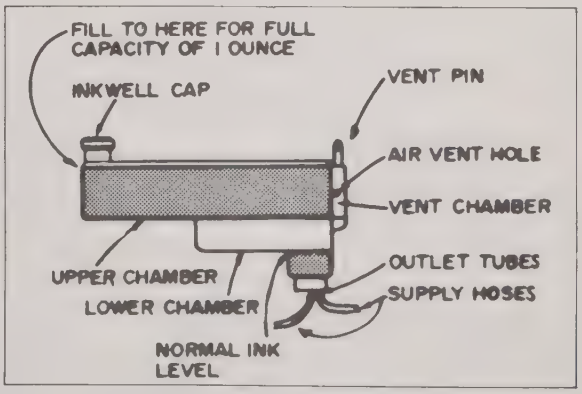


FIGURE 3-5. Inkwell Assembly.

seal the air vent hole (Figure 3-5). Remove inkwell cap by pulling it straight off and fill the upper chamber with ink, using the filler syringe (Figure 3-6). The lower chamber of the inkwell will automatically fill to only the normal level indicated in Figure 3-5. Replace the inkwell cap. Lift the vent pin so that the air hole is open to the atmosphere.

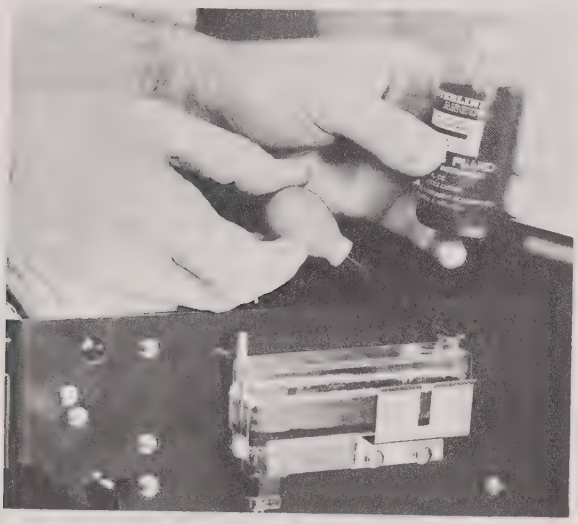


FIGURE 3-6. Filling Inkwell.

CAUTION

Never remove inkwell cap without first pushing the vent pin downward, sealing the air vent hole. This will eliminate the danger of the lower chamber overfilling which may result in excessive bleeding and leakage at pen points.

(e) To prime the system, release and tilt down the chart transport to its service position. This will lift the pens and expose the points for priming.

(f) Compress the bulb of the primer syringe and gently fit the pen point into the rubber tip as shown in Figure 3-7. Release bulb slowly, then repeat until ink appears in the glass tube of the syringe. Repeat for all pens and the systems are ready for use.

NOTE: To insure a continuous record and eliminate repriming procedures, always keep each system supplied with ink.

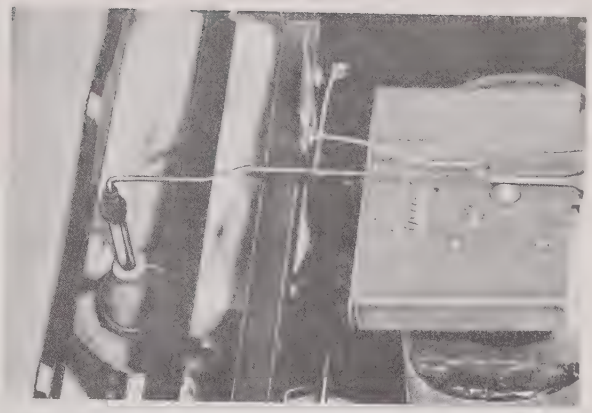


FIGURE 3-7. Priming Pen With Syringe.

ADJUSTMENTS

Although RectiGRAPH recorders are properly set up and tested before leaving the factory, certain operator adjustments are provided for each analog channel. The recommended methods for making these adjustments are as follows:

PEN BALANCE: Adjustable weights are provided on the rear of each pen staff for balancing the element. To perform this adjustment, see that the pen is full of ink and proceed with the following steps:

1. Open case door, turn off power, and slide out chassis to service position.

2. Loosen back nut on rear of pen staff and turn front nut forward or backward as required for balance. Weights will remain in position when screwed tightly against each other.

3. Check operation after weights are adjusted and repeat adjustment if necessary.

Pen balance should be such that the pen point slightly bounces up from the chart when the top roller of the chart transport is tapped with one finger. If maximum response speed is desired, pen-point pressure must be no greater than necessary to produce satisfactory inking.

ZERO ADJUST: Zero setting of each pen element must be checked periodically to insure accurate recording. Before attempting this adjustment for each channel, however, make certain that no signal is applied to the input terminals and that the pen is full of ink and is correctly balanced. To zero each channel, proceed with the following steps:

CAUTION

If a correct zero setting cannot be obtained, refer to the troubleshooting procedures in the Maintenance Section. DO NOT BEND PEN STAFF.

1. Open case door and pull chassis out to its service position.

2. Locate zero lever at base of movement beneath front portion of chassis. (Figure 3-8)

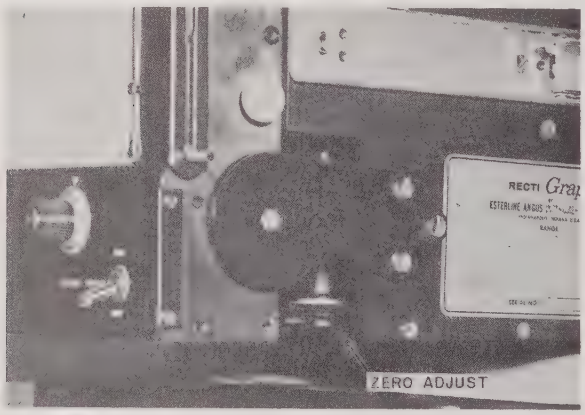


FIGURE 3-8. Zero Adjust Lever.

3. Shift the zero lever laterally and tap lightly on the top roller of the chart transport until the pen point comes to rest exactly on the zero line of the chart span.

NOTE: Recording errors may be introduced if zero is shifted to a position other than that for which the instrument is designed.

PEN LIFTER

A mechanical pen lifter is provided as a standard feature on all RectiGRAPH recorders. This device permits the operator to manually raise or lower the recording pens as desired. The actuating lever for the lifter bar is located in the upper-right corner on the chart transport frame. To raise the pen elements merely pull outward on the tab labeled "PEN LIFTER". The pens may be lowered at any time by pushing this tab inward.

An electrical pen lifter is also available as an option. This feature permits the operator to actuate the lifter bar either locally or remotely by the application of external power. Input connections for this option are shown in Figure 3-3.

SECTION III - MAINTENANCE

The component modules employed in RectiGRAPH recorders are of sturdy construction and are designed for long, trouble-free operation. Nevertheless, they should receive the care afforded any precision piece of equipment to extend their useful life. Should adjustment or minor service become necessary in the field, refer to the maintenance procedures that follow. See Part 2 of this manual for chart drive maintenance. In the few cases where major repairs are necessary, contact your local Esterline Angus representative for instructions.

WARNING

To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

Periodic maintenance schedules should be established which include inspecting, cleaning, adjusting, and checking operation of the measuring systems. Refer to the procedures in PART 2, Section III of this manual for Chart Drive maintenance.

A visual inspection of the measuring systems and inking components should be made at each maintenance period with particular attention to the following:

1. Ink and chart supplies.

2. Accumulation of dirt or other foreign material within the instrument.

3. Leaky or clogged inking systems.

4. See that each channel has a rectilinear trace.

5. Worn or bent pen elements.

6. Check zero adjustments.

7. Look for damaged wiring or loose connections.

8. See that all screws and other hardware are tight.

If any of the above items are evident, corrective measures should be taken without delay.

INKING SYSTEM:

To achieve proper inking, the ink supplies and pen elements must be inspected regularly. Ink should be added whenever needed, and the pen points kept free from dirt, lint, and dried ink at all times. Clean all inking tools after each use.

Avoid spilling ink on instrument mechanism. If ink is spilled, clean immediately. EA recording ink is water-based and may be removed with a wet cloth. Alcohol may be used to remove dried ink spots from metal surfaces.

If there appears to be excessive flow of ink at all times, or bleeding from the pens, inspect mounting of the inkwell. If the inkwell is too high in its mounting bracket, the ink level will be too high for proper feeding. Make sure the inkwell is pressed down in the bracket and is tightly clamped in position.

Adding Ink:

The inkwells may be refilled by the following steps:

1. Push the vent pin downward to seal off the air hole in inkwell vent chamber.

2. Remove inkwell cap and fill the well with Esterline Angus ink using filler syringe (Figure 3-6).

3. Replace inkwell cap and lift vent pin upward uncovering air hole in vent chamber.

NOTE: If lower chamber of inkwell should fill with ink because cap was removed without first closing the air vent hole, prime the system from the pen point until the ink in the lower chamber reaches the normal level indicated in Figure 3-5.

Cleaning Procedures:

Intermittent writing or a tendency of the ink to spread on the chart paper are often indications

that the system should be cleaned. Intervals for cleaning will depend upon environmental conditions and the nature of instrument operation.

If records are obtained with large and frequent excursions of the pen, or at relatively fast chart speeds, ink will flow rapidly and there will be little chance of the system clogging. If the system has long idle periods, on the other hand, it may be necessary to clean the system after each use.

Once a month, or oftener if necessary, the pens should be cleaned by drawing ink through each system. Position the rubber tip of the primer syringe over the pen point and prime the system until several drops of ink come from the pen point; blot the tip and check operation. This routine procedure should remove any paper fiber or dirt that has accumulated in the pen point.

If this procedure fails to restore satisfactory inking, disconnect the flexible hose from the metal feed tube and remove the pen element from the instrument. Fill the flusher syringe with clear water and backflush the pen element.

If the pen is clogged and will not permit an adequate flow of water, apply heat near the tip of the pen using a soldering iron. Be careful not to apply too much heat. While the end of the pen is warm, repeat the backflushing procedure with warm water. Replace the pen element in the instrument, reprime the inking system, and check operation.

If pen tip remains clogged, insert cleaning wire in pen point and carefully work wire straight in and out of pen; then repeat flushing procedures. Do not use cleaning wire unless absolutely necessary. Keep it centered in pen and avoid scraping sides of orifice. If the tip has become permanently damaged, it will be necessary to replace the entire pen element assembly.

SHUTDOWN:

If the recorder is to be stored or remain inactive for more than 30 days, all ink should be removed and each channel system cleaned. Close air hole in vent tube of inkwell; disconnect the supply hose from the bottom of the inkwell and permit the ink to drain from the pen and hose assembly. Backflush the pen assembly and hose using clear water in the flusher syringe.

Slide the inkwell from its mounting bracket, remove the inkwell cap, and uncover the air hole in the vent tube. Pour out the ink and flush the inkwell with clear water. Replace the inkwell cap, close the air hole, and reassemble the inking system in the instrument.

> NOTE: If instrument is to be transported over any long distance, follow original factory packing procedures.

CALIBRATION

Instrument calibration should be checked against a known-accurate standard. Disconnect the measured signal source, balance the pen, zero the system, and connect the calibration signal source to the correct input terminals. If recording errors exceed the accuracy limits specified for the overall system, follow the service procedures given under "TROUBLESHOOTING." If difficulties persist, return the instrument to the factory for repair and recalibration (consult your local Esterline Angus representative for shipping instructions).

The accuracy of a recorder may be questioned because its readings do not agree with those of indicating instruments in the same circuit. In such a case, make sure that the indicators themselves are properly connected and are accurately calibrated. It is frequently found that indicating instruments are in error due to incorrect connections or because they have suffered physical or electrical damage. Often, this is not discovered until a recorder is connected into the same circuit and a direct comparison made.

MOTION TRANSLATOR ADJUSTMENT

If the writing system of any one channel is not producing a rectilinear trace, it may be necessary to adjust the motion translator mechanism located on top of the meter movement assembly. Before proceeding with this adjustment, however, make an inspection of the instrument for the following:

1. See that the chart transport is latching properly in its upright position, and that the drive roll is parallel with the front of the chassis. Clearance between the transport subassembly and the chassis should be 3/16 in. If clearance should change due to wear, it may be corrected by adjusting the two small screws in the forward edges of the chassis assembly. The pens must travel across the chart at the highest tangent point on the drive roll.

2. Make sure that the pen element is properly seated in the movement fork assembly, and that the flexible inking hose is not too taut or twisted.

3. Check for a bent pen staff, and see that the staff clears all surrounding objects through its entire deflection.

CAUTION

DO NOT bend pen staff. The pen assembly has a specific length and configuration for proper rectilinear recording.

ADJUSTMENT PROCEDURES:

To gain access to the adjustable mechanism, pull out chassis to its service position; remove two screws from the "pen lift" cover on top of the movement; and remove the cover by sliding it out from under the pen element.

CAUTION

Use extreme care to prevent damage of pen element and translating mechanism.

Coarse Adjustment:

1. With chart installed and transport in its normal operating position, adjust the Zero lever until the pen rests at midscale on the chart. (Figure 3-8)

2. Grasp rotating pulley between thumb and forefinger and loosen the coarse adjustment screw (See Figure 3-9). Release pulley.

3. Gripping the jewel assembly, hold the driving arm in the center (rest) position of the meter movement. While holding the driving arm in this position, pivot the writing element fork bracket until the pen tip is positioned at midscale on the chart.

4. Grasp the rotating pulley between thumb and forefinger to hold the pen tip at midscale and tighten the coarse adjustment screw.

Fine Adjustment:

1. Grasp jewel assembly and hold driving arm so that pen tip is at midscale on chart.

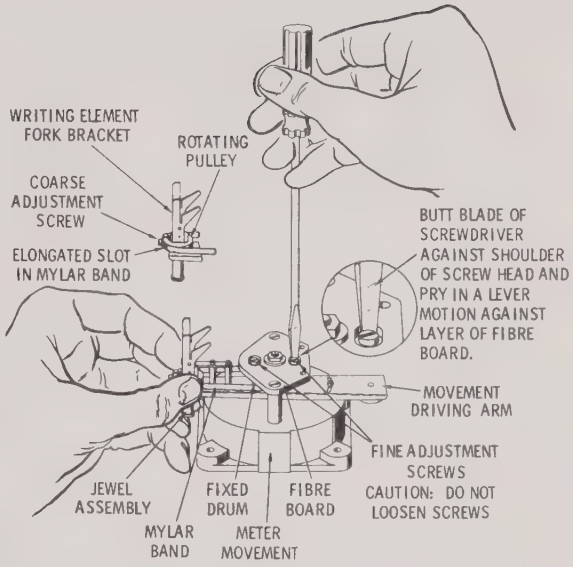

WRITING ELEMENT FORK BRACKET
ROTATING PULLEY
COARSE ADJUSTMENT SCREW
ELONGATED SLOT IN MYLAR BAND
BUTT BLADE OF SCREWDRIVER AGAINST SHOULDER OF SCREW HEAD AND PRY IN A LEVER MOTION AGAINST LAYER OF FIBRE BOARD.
MOVEMENT DRIVING ARM
FINE ADJUSTMENT SCREWS
CAUTION: DO NOT LOOSEN SCREWS
JEWEL ASSEMBLY
FIXED DRUM
FIBRE BOARD
MYLAR BAND
METER MOVEMENT

FIGURE 3-9. Motion Translator Adjustment Points.

2. Manually advance the chart until the pen tip is placed directly on a horizontal time line (preferably a lighter-faced line) at midscale on the chart.

3. Grasp jewel assembly and pivot driving arm so that a trace is made from one extreme of the chart span to the other. The trace should be directly superimposed on the horizontal time line across the full width of the chart span.

4. Repeat steps 1, 2, and 3 several times in order to obtain conclusive indications.

5. If the traces are not rectilinear, observe the traces at the left extreme of the chart span and proceed as follows:

a. Grasp jewel assembly and deflect the pen element to the left extreme of the chart span where non-rectilinearity becomes apparent and keep the pen positioned at this point.

b. If the trace is ahead of the time line, use the blade of a screwdriver to pry the front adjustment screw to the left until the trace is brought back onto the time line (See insert in Figure 3-9). After each adjustment, manually advance the chart to a new position and manually deflect the pen element full scale to observe the trace. Repeat steps 5a and 5b until the trace becomes rectilinear.

NOTE: When adjustments are made to correct the rectilinear error at the left end of the chart span, the error is also automatically corrected at the right end of the span.

After adjustments are completed, replace the top cover and adjust zero as desired.

TROUBLESHOOTING

If the recorder is completely inoperative, check the line fuse (F301) located on the outer-left side of the chassis. Refer to the wiring diagram Figure 3-13 for other possible causes of power failure. See PART 2, Section III of this manual for troubles associated with the chart drive system.

If it is suspected that one channel of the recorder is not functioning properly the following service procedures are recommended:

1. See that the pen is seated properly in the movement fork, and check the zero setting as described under "ZERO ADJUST." If instrument will not zero, check the pen balance adjustment.

2. Check all external connections and see that they are clean and tight.

3. See that instrument is not positioned near a strong magnetic field or subjected to other adverse environments.

4. Check freedom of movement by drawing pen across chart. Do not place strain on pen staff, but expose chassis and actuate pen by carefully swinging lower bearing assembly located at the rear of the motion translator mechanism.

5. If movement is erratic, examine clearances of pen staff and flexible hose. Hose must not be twisted or kinked.

6. If steps 1 through 5 fail to isolate the trouble, remove the chassis from the case, clean the assembly, and look for physical or electrical damage. Check continuity of measuring circuitry (See Figures 3-10 and 3-12).

7. Examine coil leads and control springs of movement by turning armature through all positions. If coil leads are burned off or control springs are damaged, return instrument to factory for service.

CAUTION

Never remove the movement assemblies from the chassis structure unless means are available to recharge the magnet-armature assemblies and recalibrate the measuring circuits.

8. Using a bridge or portable ohmmeter, check DC resistance of measuring circuit components (Figure 3-12). If values differ markedly from those shown on Data Sheet, replace faulty components or contact Esterline Angus for service instructions.

DISASSEMBLY

Chassis Removal:

To remove the entire chassis from the recorder case, proceed as follows:

CAUTION

Before removing entire chassis from case, disconnect external wiring and loosen screws securing input terminal panel to rear of case.

1. Remove eight screws securing the cover plate to the rear of the case, and disconnect all external wiring.

2. Loosen the four screws securing the rear terminal panel to the case (1/4 turn each).

NOTE: When the two screws on each side of the terminal panel are loosened, the panel will drop down and attach to the chassis.

3. Open the case door. Place the Masonite packing plate (retained when case unpacked) below chassis for support.

4. Remove fourteen screws from sides of case (seven from each side). Pull chassis forward and out of case on Masonite support plate.

Installation:

To install the chassis in the recorder case, proceed as follows:

1. Place the chassis on the Masonite support plate and slide back into case.

2. Replace fourteen screws in sides of case.

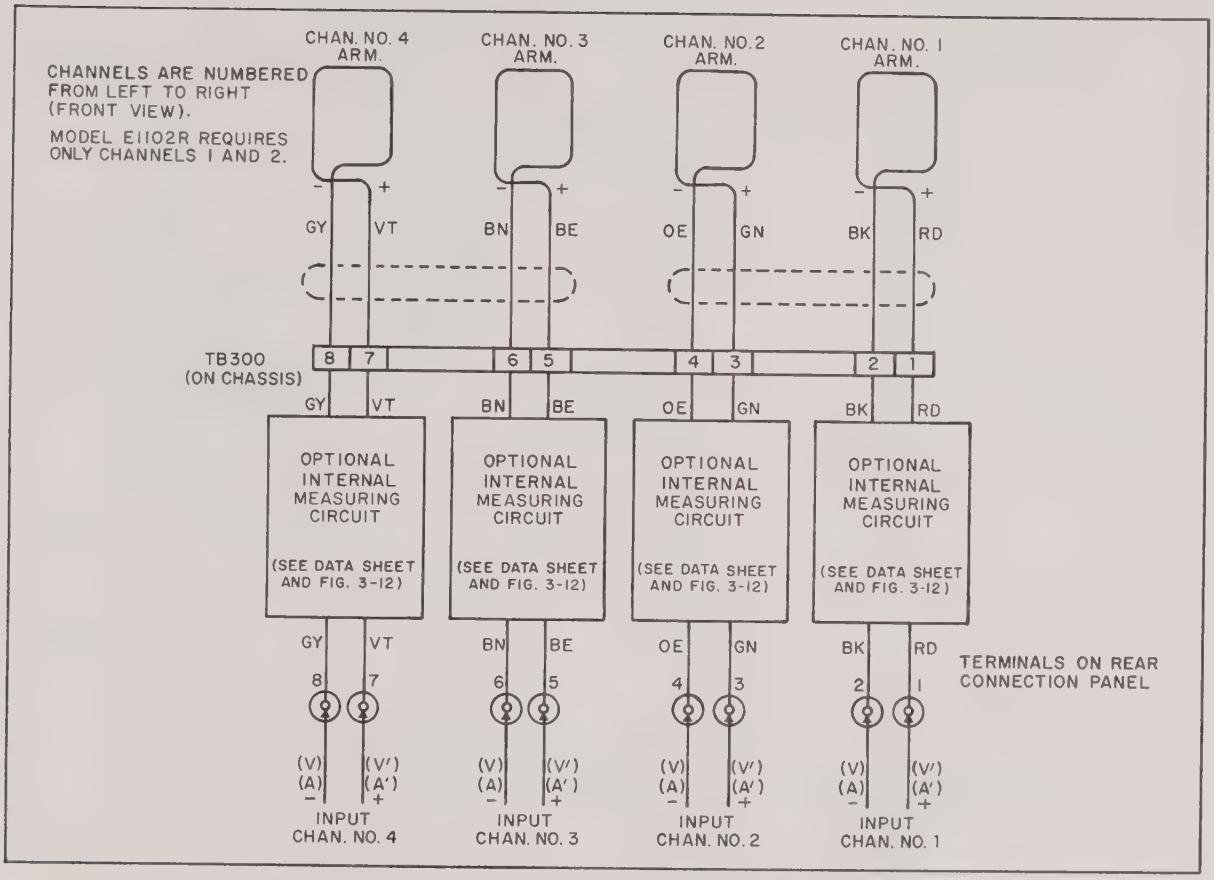

CHANNELS ARE NUMBERED FROM LEFT TO RIGHT (FRONT VIEW).
MODEL E1102R REQUIRES ONLY CHANNELS 1 AND 2.
CHAN. NO. 4 ARM.
CHAN. NO. 3 ARM.
CHAN. NO. 2 ARM.
CHAN. NO. 1 ARM.
GY VT
BN BE
OE GN
BK RD
TB300 (ON CHASSIS)
8 7 6 5 4 3 2 1
OPTIONAL INTERNAL MEASURING CIRCUIT
(SEE DATA SHEET AND FIG. 3-12)
TERMINALS ON REAR CONNECTION PANEL
(V) (A) − (V') (A') +
INPUT CHAN. NO. 4
INPUT CHAN. NO. 3
INPUT CHAN. NO. 2
INPUT CHAN. NO. 1

FIGURE 3-10. Internal Signal-Circuit Wiring Diagram.

3. Raise the terminal panel from the rear of the case and tighten the two screws on each side of the panel.

4. Connect all external wiring. See connection diagram Figure 3-3.

NOTE: If the recorder has special customized features, refer to the diagram supplied in the appendix of this manual.

5. Replace the cover plate on the rear of the case. Chassis installation is complete.

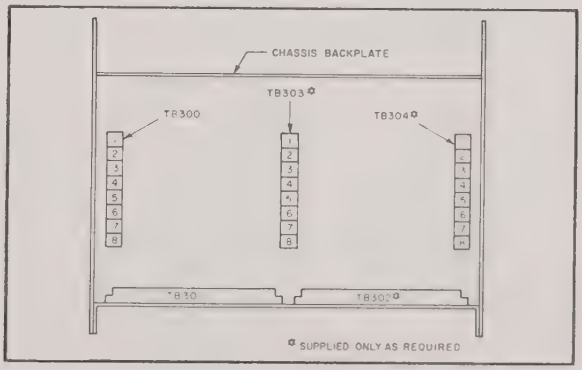


FIGURE 3-11. Location of Chassis Terminal Blocks (Rear View).

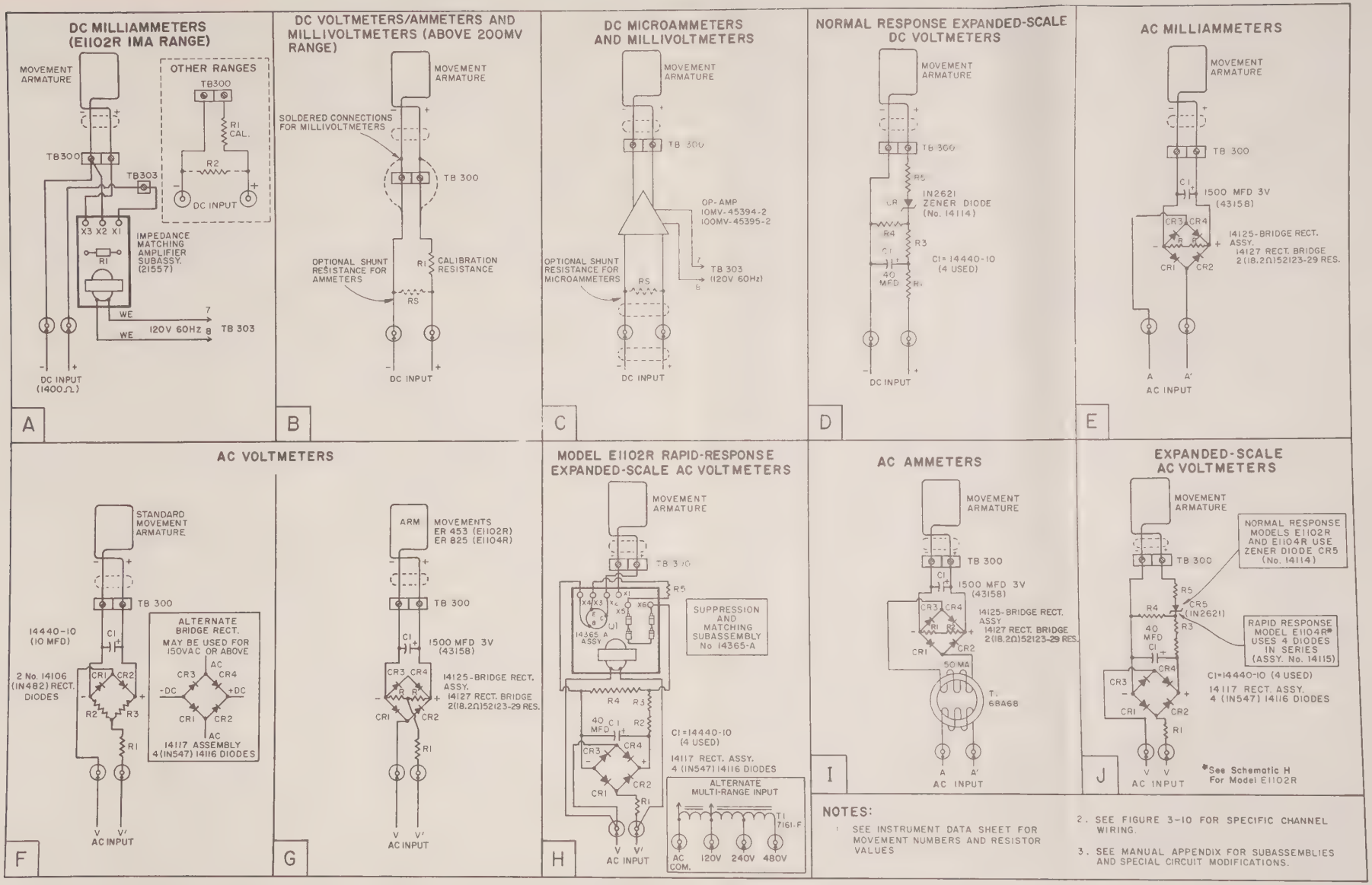


FIGURE 3-12. Measuring Circuit Schematics.

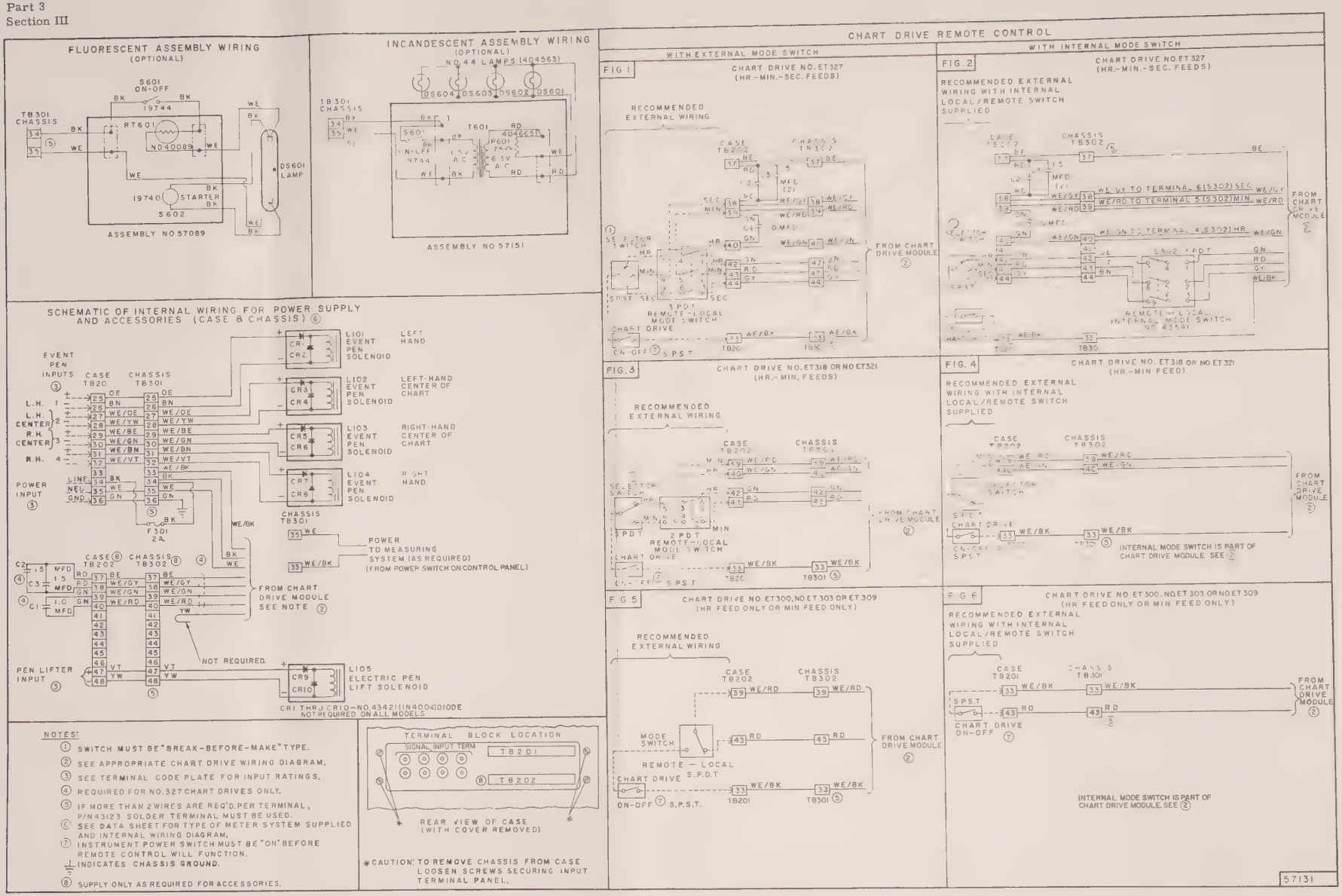

FLUORESCENT ASSEMBLY WIRING
(OPTIONAL)
S601 ON-OFF
19744
TB301 CHASSIS
RT601
ND40089
DS601 LAMP
19740 STARTER
S602
ASSEMBLY NO 57089
INCANDESCENT ASSEMBLY WIRING
(OPTIONAL)
NO 44 LAMPS (404563)
DS604 DS603 DS602 DS601
TB301 CHASSIS
S601 ON-OFF 9744
T601
R601
ASSEMBLY NO 57151
SCHEMATIC OF INTERNAL WIRING FOR POWER SUPPLY AND ACCESSORIES (CASE 8 CHASSIS) ⑥
EVENT PEN INPUTS ③
CASE TB201
CHASSIS TB301
L.H.
L.H. CENTER
R.H. CENTER
R.H.
POWER INPUT ③
LINE
NEU
GND
F301 2A.
LI01 EVENT PEN SOLENOID
LEFT HAND
LI02 EVENT PEN SOLENOID
LEFT-HAND CENTER OF CHART
LI03 EVENT PEN SOLENOID
RIGHT-HAND CENTER OF CHART
LI04 EVENT PEN SOLENOID
RIGHT HAND
CHASSIS TB301
POWER TO MEASURING SYSTEM (AS REQUIRED) (FROM POWER SWITCH ON CONTROL PANEL)
FROM CHART DRIVE MODULE SEE NOTE ②
CASE ⑧ TB202
CHASSIS ⑧ TB302
PEN LIFTER INPUT ③
NOT REQUIRED.
LI05 ELECTRIC PEN LIFT SOLENOID
CR1 THRU CR10—NO.43421 (IN4004) DIODE
NOT REQUIRED ON ALL MODELS
NOTES:
① SWITCH MUST BE "BREAK-BEFORE-MAKE" TYPE.
② SEE APPROPRIATE CHART DRIVE WIRING DIAGRAM.
③ SEE TERMINAL CODE PLATE FOR INPUT RATINGS.
④ REQUIRED FOR NO.327 CHART DRIVES ONLY.
⑤ IF MORE THAN 2 WIRES ARE REQ'D. PER TERMINAL, P/N43123 SOLDER TERMINAL MUST BE USED.
⑥ SEE DATA SHEET FOR TYPE OF METER SYSTEM SUPPLIED AND INTERNAL WIRING DIAGRAM.
⑦ INSTRUMENT POWER SWITCH MUST BE "ON" BEFORE REMOTE CONTROL WILL FUNCTION.
⏚ INDICATES CHASSIS GROUND.
⑧ SUPPLY ONLY AS REQUIRED FOR ACCESSORIES.
TERMINAL BLOCK LOCATION
SIGNAL INPUT TERM
TB201
⑧ TB202
REAR VIEW OF CASE (WITH COVER REMOVED)
*CAUTION: TO REMOVE CHASSIS FROM CASE LOOSEN SCREWS SECURING INPUT TERMINAL PANEL.
CHART DRIVE REMOTE CONTROL
WITH EXTERNAL MODE SWITCH
FIG 1
CHART DRIVE NO. ET327 (HR.-MIN.-SEC. FEEDS)
RECOMMENDED EXTERNAL WIRING
SELECTOR SWITCH
3 PDT REMOTE-LOCAL MODE SWITCH
CHART DRIVE ON-OFF ⑦ S.P.S.T.
FROM CHART DRIVE MODULE ②
FIG. 3
CHART DRIVE NO. ET318 OR NO ET321 (HR.-MIN. FEEDS)
RECOMMENDED EXTERNAL WIRING
2 PDT REMOTE-LOCAL MODE SWITCH
FIG 5
CHART DRIVE NO ET300, NO ET303 OR ET309 (HR FEED ONLY OR MIN FEED ONLY)
RECOMMENDED EXTERNAL WIRING
MODE SWITCH
REMOTE — LOCAL
CHART DRIVE S.P.D.T ON-OFF ⑦ S.P.S.T.
WITH INTERNAL MODE SWITCH
FIG. 2
CHART DRIVE NO. ET327 (HR.-MIN.-SEC. FEEDS)
RECOMMENDED EXTERNAL WIRING WITH INTERNAL LOCAL/REMOTE SWITCH SUPPLIED
WE GY TO TERMINAL 6 (S302) SEC.
WE RD TO TERMINAL 5 (S302) MIN.
WE GN TO TERMINAL 4 (S302) HR.
REMOTE-LOCAL INTERNAL MODE SWITCH NO 43541
FIG. 4
CHART DRIVE NO. ET318 OR NO ET321 (HR.-MIN FEED)
RECOMMENDED EXTERNAL WIRING WITH INTERNAL LOCAL/REMOTE SWITCH SUPPLIED
INTERNAL MODE SWITCH IS PART OF CHART DRIVE MODULE SEE ②
FIG 6
CHART DRIVE NO. ET300, NO ET303 OR NO ET309 (HR FEED ONLY OR MIN FEED ONLY)
RECOMMENDED EXTERNAL WIRING WITH INTERNAL LOCAL/REMOTE SWITCH SUPPLIED
INTERNAL MODE SWITCH IS PART OF CHART DRIVE MODULE, SEE ②
57131

FIGURE 3-13. Power and Accessory Wiring Diagram.

PART 4
ILLUSTRATED PARTS BREAKDOWN

GENERAL

In this section, the instrument is broken down into a series of major assemblies, or groups of related parts which are illustrated in the various sections. Parts are identified separately in each illustration by an index number which, in turn, is listed in the appropriate parts list for the illustration. Since many parts are illustrated more than once in the Parts Breakdown and index numbers are assigned separately to the illustrations, the same part may not always have the same index number. For this reason, it is necessary to check the Figure No. column of the Parts List before using it to identify an index number. The Qty. per Unit column refers to the quantity used in the unit shown in the illustration and is not necessarily the total quantity used in the instrument. Commercially-available hardware items, although illustrated, are not indexed and no part numbers are listed.

INDENTATION

Certain parts in the parts list are indented in the Description column to indicate that they are subassemblies or parts of the next higher assembly listed above them. In the case of double indentation, the part is used in an assembly which is itself a subassembly of the part listed above.

ORDERING INFORMATION

To insure prompt delivery of the correct parts, always list the model number of the instrument, the serial number, and give a complete description from the breakdown listing as well as the part number. When ordering a part that has not been identified in this breakdown, give the size (dimensions), location in the instrument, and its function. If it is part of an assembly, give the assembly number. If possible, return the part for identification.

CONTENTS

Section I ..... Case Assembly
Section II ..... Chassis Assembly
Section III ..... Chart Transport Subassembly
Section IV ..... Chart Drive Assembly

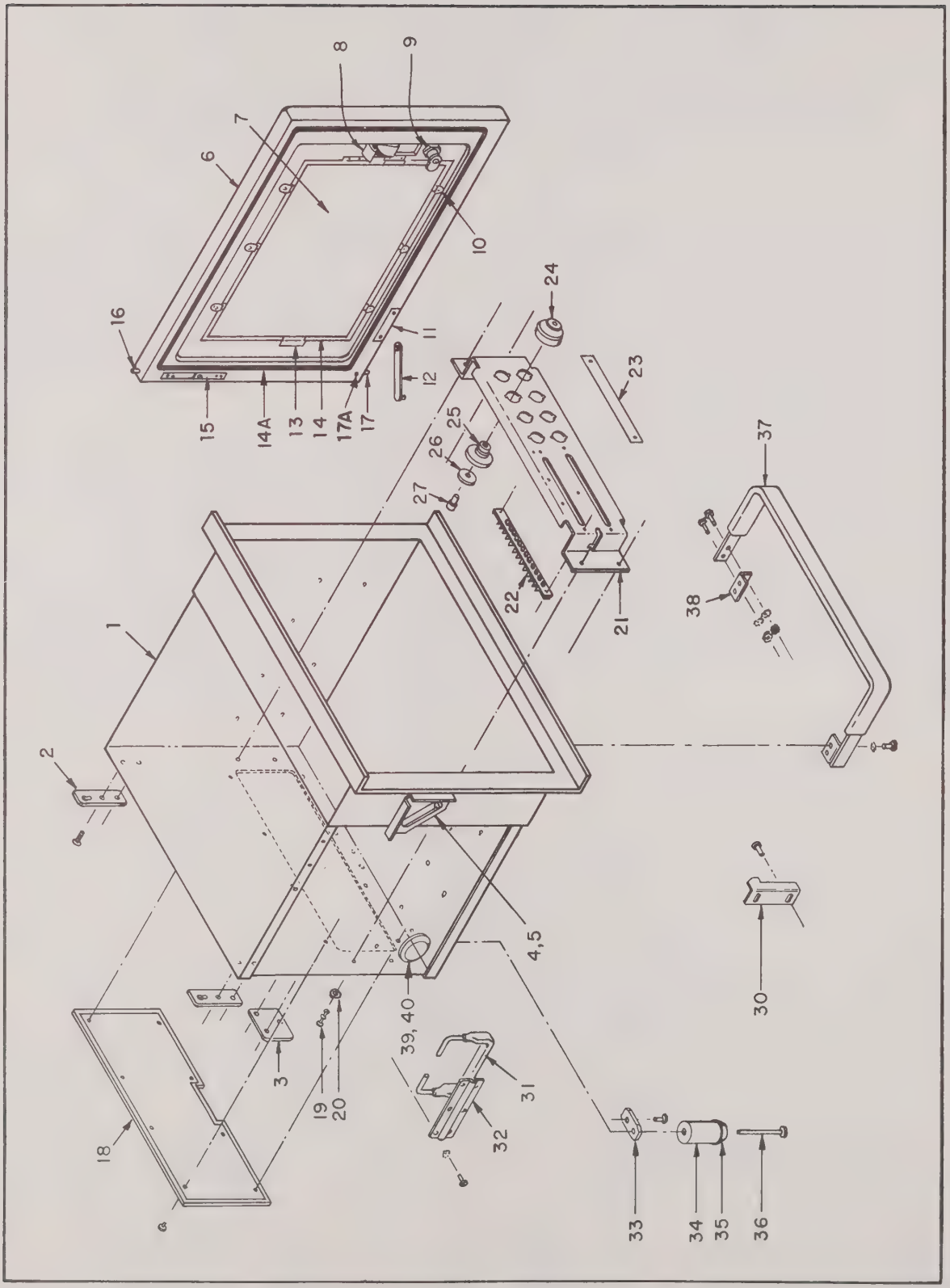


FIGURE 4-1. Instrument Case Assembly.

SECTION I - INSTRUMENT CASE ASSEMBLY

REPLACEMENT PARTS LIST

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-1	1	51625-7-14	Case, Instrument (Light Gray)	1
		51625-7-11	Case, Instrument (Charcoal)	1
		51625-7-50	Case, Instrument (Two-Tone)	1
	2	241005	Bracket, Hanger Mounting (Top)	2
	3	241004	Bracket, Hanger Mounting (Bottom)	1
	4	241003	Bracket, Panel Mounting (Right Hand)	1
	5	241002	Bracket, Panel Mounting (Left Hand)	1
	6	51576	Door Assembly (Specify Color)	1
	7	51578	. Glass, Door	1
	8	51538	. Latch Assembly, Door	1
	9	19830	. Lock Assembly (with key)	1
	10	41096	. Clip, Door glass	6
	11	51584	. Bracket, Door stop	1
	12	51595	. Arm, Door stop	1
	13	51570	. Clip, Door glass retaining	2
	14	0660	. Gasket, Glass	1
	14A	0373	. Gasket, Door	1
	15	51580	. Retractor Assembly, Hinge pin	1
	16	51579	. Pin, Door hinge (Upper)	1
	17	51588	. Pin, Door hinge (Lower)	1
	17A	SS-083206	. Set Screw	1
		51500	• Socket Screw Key (Wrench)	1
	18	57086	Cover, Case (State color)	1
	19	57093	Fastener, 1/4 turn	4
	20	57094	Retainer, Split ring	4
	21	57099-*	Panel, Input terminal	1
	22	57055	Terminal Block (TB201/TB202)	1 or 2
	23	57035-3	Decal, Terminal strip marker (25-36)	1
		57035-4	Decal, Terminal strip marker (37-48) (Used only with optional accessories)	1
	24	8847	Cap, Input terminal	4 or 8
	25	18845	Insulator, Input terminal	4 or 8
	26	18842	Marker, Terminal (State lettering on marker)	4 or 8
	27	18846	Terminal, Input (See Data Sheet)	4 or 8
	28, 29		(Not used)	
	30	57160	Latch Bracket	1
	31	51531-2	Handle (Optional)	2
	32	51531-1	Clamp, Handle (Optional)	2
	33	51604	Nut	2
	34	51530	Laboratory Feet	2
	35	45024	Bumper, Rubber	2
	36	IH51032-36J	Screw	2
	37	51528	Leg Assembly, Tip proof	1
	38	51526	Angle, Mounting	2
	39	ND40180-8	Grommet	4
	40	ND40179-5	Plug, Button	4

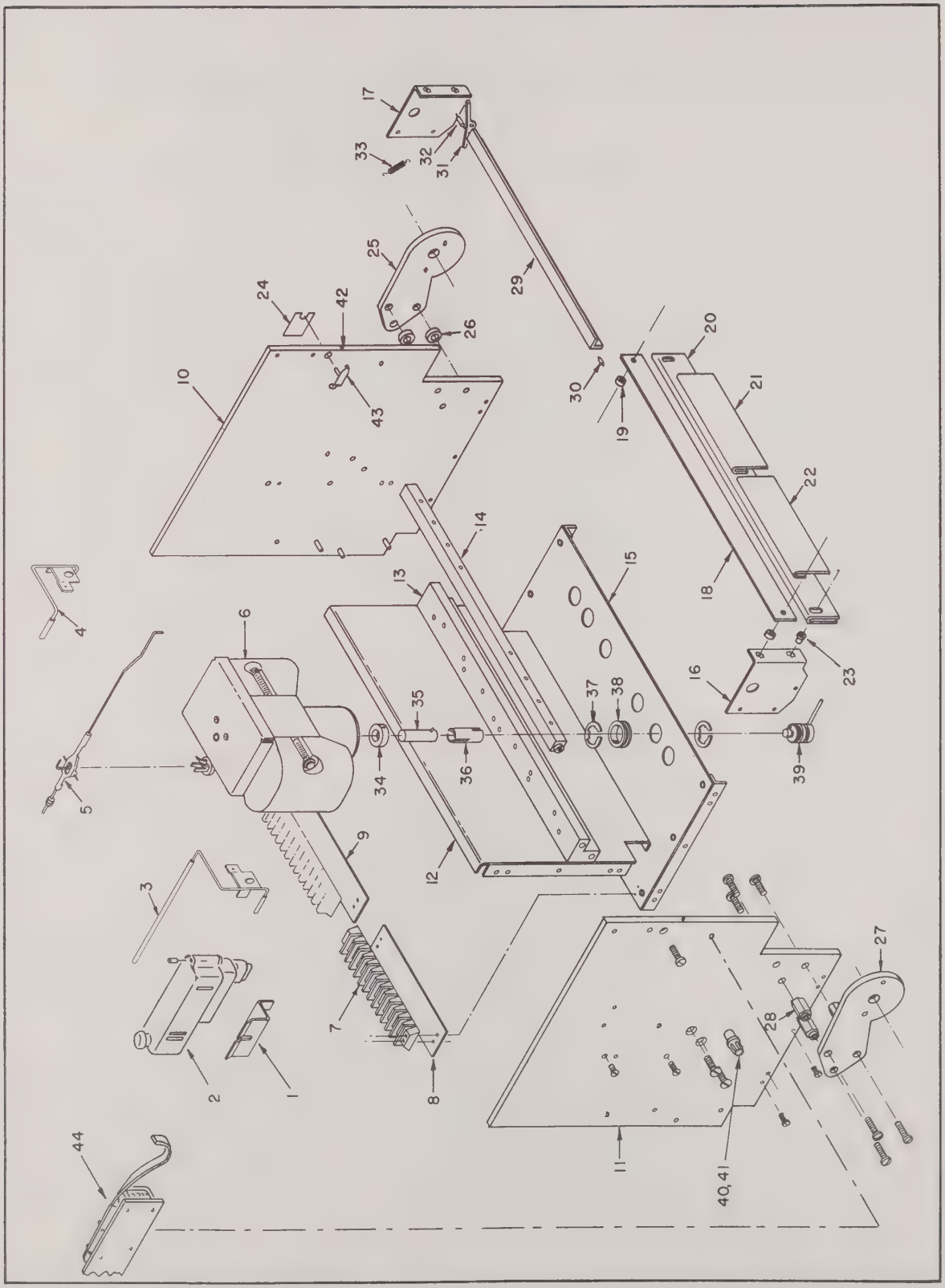


FIGURE 4-2. E1102R Chassis Assembly.

SECTION II - CHASSIS ASSEMBLY

REPLACEMENT PARTS LIST
E1102R CHASSIS ASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-2	1	57073	Bracket, Inkwell mounting	2
	2	61400	Inkwell	2
	3	57026	Feed Tube Assembly, Left Hand	1
	4	57027	Feed Tube Assy, Right Hand	1
	5	21456	Pen Element Assembly	2
	6	57096	Measuring Element (See Data Sheet)	2
	7	51040-12	Terminal Block	2
	8	41041-37	Marker, Terminal Block	1
	9	41041-38	Marker, Terminal Block	1
	10	57011	Side Plate, Chassis (Right Hand)	1
	11	57012	Side Plate, Chassis (Left Hand)	1
	12	57062	Back Plate Assembly	1
	13	57015	Mounting Bar, Rear	1
	14	57017	Support Bar, Feed Tube	1
	15	57060	Bottom Plate Assembly	1
	16	57066	Scale Mounting Bracket, (Left Hand)	1
	17	57065	Scale Mounting Bracket, (Right Hand)	1
	18	57083	Trim Plate	1
	19	57084	Trim Plate Spacer	2
	20	57039	Bracket, Scale mounting	1
	21	57002-*	Scale (See Data Sheet)	1
	22	57002-*	Scale (See Data Sheet)	1
	23	57082	Spacer, Scale mounting	2
	24	57080	Decal, Release	1
	25	57020	Bracket, Chart Drive Support (Right Hand)	1
		12481	Stud, Extra Change Gears	1
	26	57097	Spacer	3
	27	57061	Bracket, Chart Drive Support (Left Hand)	1
	28	57033	Spacer	3
	29	52047	Bar, Pen lifter	1
	30	52053	Spacer, Shaft (Left Hand)	1
	31	57200	Lever, Pen Lift	1
	32	52053	Spacer, Shaft (Right Hand)	1
	33	52074	Spring, Pen Lift	1
	34	14041	Collar, Zero Shift	2
	35	57045	Rod And Pin Assembly, Zero Shift	2
	36	12674-B	Coupling, Zero Shift	2
	37	ND40140-13	Ring, Retaining	4
	38	57054	Bushing, Nylon	2
	39	57042	Coupling Head Assembly	2
	40	14358	Holder, Fuse	1
	41	14359-2	Fuse, 3 AG (F301)	1
	42	ND40107-6	Nylon Set Screw	2
	43	57056	Latch	1
	44	57196-1	Slide Assembly (Right Hand)	1
		57196-2	Slide Assembly (Left Hand)	1

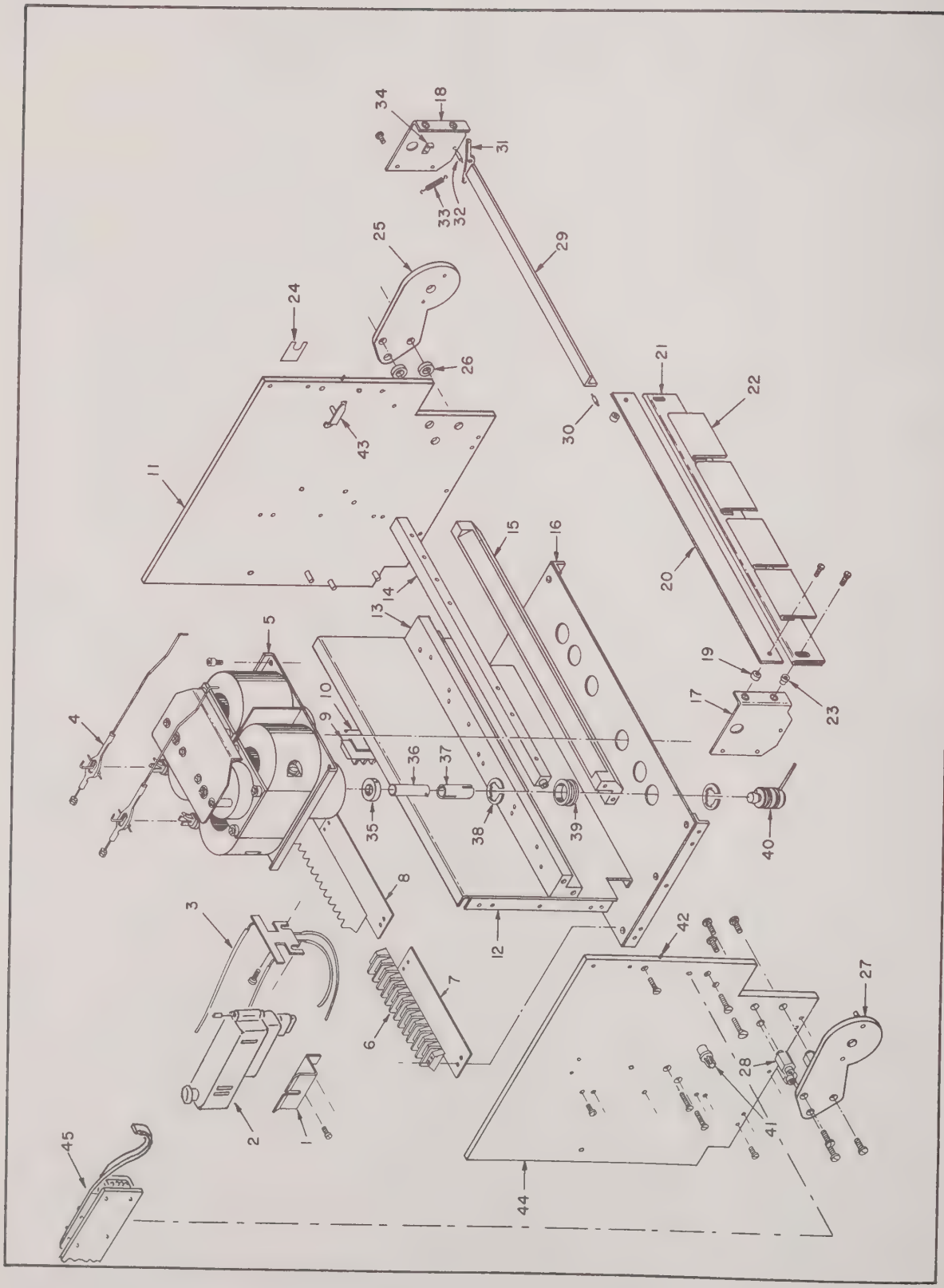


FIGURE 4-3. E1104R Chassis Assembly.

REPLACEMENT PARTS LIST
E1104R CHASSIS ASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-3	1	57073	Bracket, Inkwell Mounting	2
	2	61400	Inkwell	2
	3	57021	Tube Assembly, Feed	2
	4	21456	Pen Element Assembly	4
	5	57072	Measuring Element (See Data Sheet)	2
	6	41040-12	Terminal Block	2
	7	41041-38	Marker, Terminal Block	1
	8	41041-37	Marker, Terminal Block	1
	9	41040-8	Terminal Block	1
	10	41041-6	Marker, Terminal Block	1
	11	57011	Side Plate, Chassis (Right Hand)	1
	12	57062	Back Plate Assembly	1
	13	57015	Mounting Bar, Rear	1
	14	57017	Support Bar, Feed Tube	1
	15	57014	Support Bar, Front	1
	16	57060	Bottom Plate Assembly	1
	17	57066	Scale Mounting Bracket (Left Hand)	1
	18	57065	Scale Mounting Bracket (Right Hand)	1
	19	57084	Spacer, Trim plate	2
	20	57083	Trim Plate	1
	21	57039	Bracket, Scale Mounting	1
	22	57004-*	Scale (See Data Sheet)	4
	23	57082	Spacer, Scale Mounting	2
	24	57080	Decal, Release	1
	25	57020	Bracket, Chart Drive Support (Right Hand)	1
		12481	Stud, Extra Change Gears	1
	26	57097	Spacer	3
	27	57061	Bracket, Chart Drive Support (Left Hand)	1
	28	57033	Spacer	3
	29	52047	Bar, Pen Lift	1
	30	52053	Spacer, Shaft (Left Hand)	1
	31	57200	Lever, Pen Lift	1
	32	52053	Spacer, Shaft (Right Hand)	1
	33	52074	Spring	1
	34	57158	Pen Lifter Stop	1
	35	14041	Collar, Zero Shift	4
	36	57045	Rod and Pin Assembly, Zero Shift	4
	37	12674-B	Coupling, Zero Shift	4
	38	ND40140-13	Ring, Retaining	8
	39	57054	Bushing, Nyliner	4
	40	57042	Coupling Head Assembly	4
	41	14358	Holder, Fuse 3 AG	1
	42	ND40107-6	Set Screw	2
	43	57056	Latch	1
	44	57012	Side Plate, Chassis (Left Hand)	1
	45	57196-1	Slide Assembly (Right Hand)	1
		57196-2	Slide Assembly (Left Hand)	1

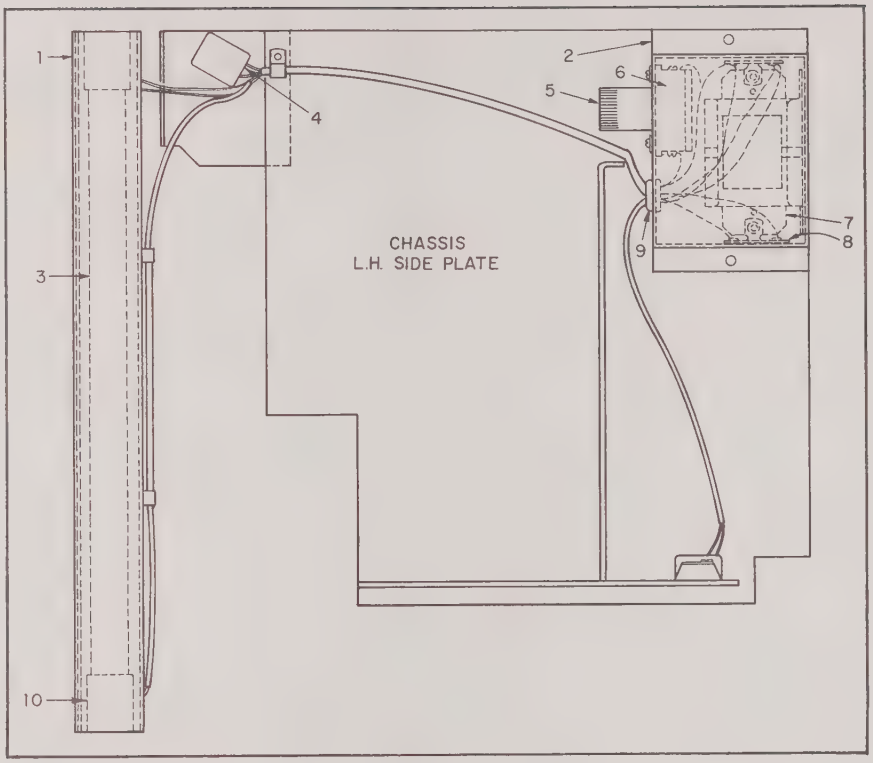


FIGURE 4-4. Fluorescent Lamp Assembly.

REPLACEMENT PARTS LIST
FLUORESCENT LAMP ASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-4	1	57036	Lamp Shield	1
	2	57090	Cover	1
	3	51539	Lamp	1
	4	19744	Switch, Lamp	1
	5	19740	Starter, Fluorescent lamp	1
	6	ND28931	Socket, Starter	1
	7	ND40089	Ballast Transformer (60 cycle)	1
		ND40089-1	Ballast Transformer (50 cycle)	1
	8	ND40074-2	Terminal Strip	2
	9	ND40180-2	Grommet	1
	10	19719	Socket, Lamp	2

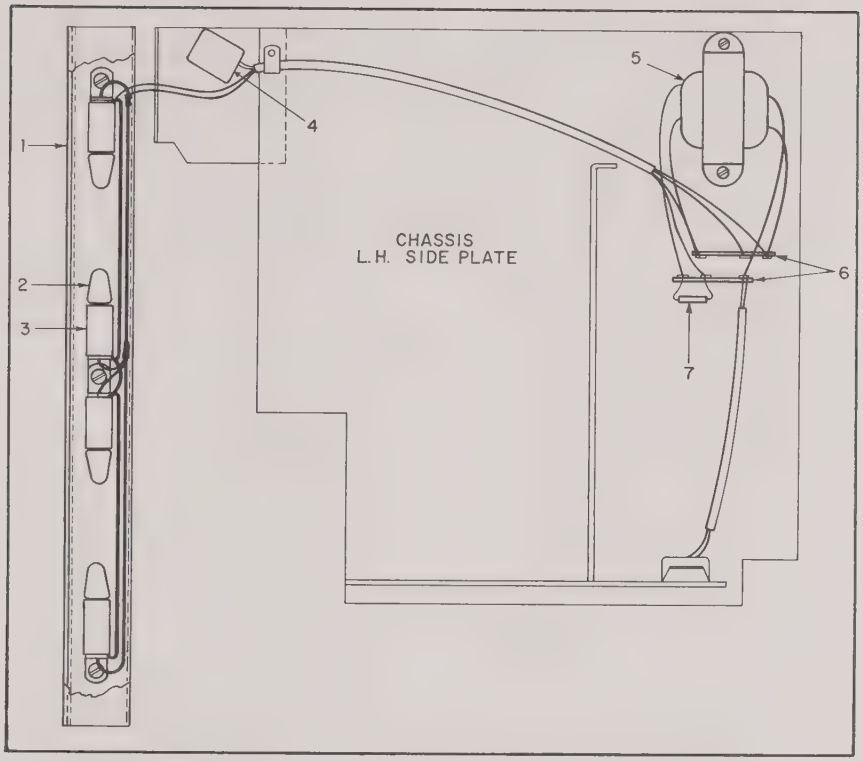


FIGURE 4-5. Incandescent Lamp Assembly.

REPLACEMENT PARTS LIST
INCANDESCENT LAMP ASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-5	1	57036	Lamp Shield	1
	2	404563	Lamp (GE44)	4
	3	52210	Socket	4
	4	19744	Switch, Lamp	1
	5	204031	Transformer	1
	6	ND40074-13	Terminal Strip	2
	7	404665	Resistor, 0.75Ω, 2W	1

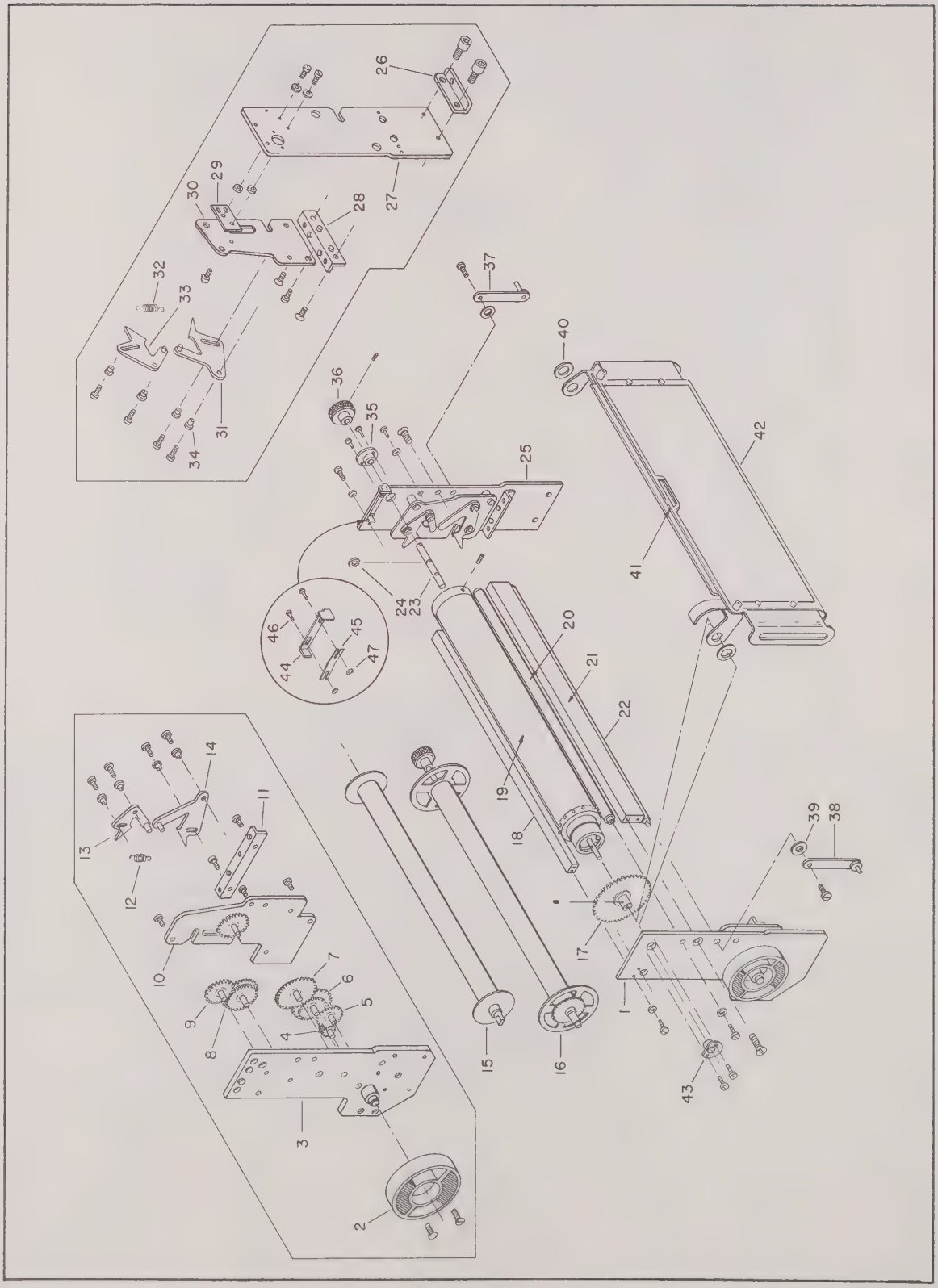


FIGURE 4-6. Universal Chart Transport Subassembly.

SECTION III - CHART TRANSPORT ASSEMBLY

REPLACEMENT PARTS LIST
UNIVERSAL CHART TRANSPORT SUBASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-6		57053-50	Universal Chart Transport Subassembly (1/2-in. base, 50 cycle drive)	1
		57053-60	Universal Chart Transport Subassembly (3/4-in. base, 60 cycle drive)	
		57100-50	Universal Chart Transport Subassembly (3/4-in. base, 50 cycle drive)	
		57100-60	Universal Chart Transport Subassembly (3/4-in. base, 60 cycle drive)	
		57101-50	Universal Chart Transport Subassembly (1.25 cm base, 50 cycle drive)	
		57101-60	Universal Chart Transport Subassembly (1.25 cm base, 60 cycle drive)	
	1	57129	. End Assembly, Left (1.25 cm or 1/2-in. base, 50 cycle drive)	1
		57052	. End Assembly, Left (1.25 cm or 1/2-in. base, 60 cycle drive)	
		57159	. End Assembly, Left (3/4-in. base, 50 cycle drive)	
		57130	. End Assembly, Left (3/4-in. base, 60 cycle drive)	
	2	57078	. . Retarder Assembly	1
	3	57050	. . Side Plate Assembly, Left	1
	4	50039	. . Input Shaft Assy (23T gear for 1/2-in and 1.25 cm 50 cycle drive)	1
		50078	. . Input Shaft Assembly (22T gear for 1/2-in. and 1.25 cm 60 cycle drive)	1
	5	50227	. . 1st Wheel Shaft Assembly (33T & 44T gears for 1/2-in. and 1.25 cm 50 cycle drive)	1
		50045	. . 1st Wheel Shaft Assembly (36T and 44T gears for 1/2-in. and 1.25 cm; 60 cycle drive)	1
		50084	. . 1st Wheel Shaft Assembly (33T and 44T gears for 3/4-in. base; 50 cycle drive)	1
		50081	. . 1st Wheel Shaft Assembly (36T and 44T gears for 3/4-in. base; 60 cycle drive)	1
	6	50229	. . 2nd Wheel Assembly (48T and 55T gears for 1.25 cm, 1/2 and 3/4-in. based; 50 cycle drives)	1
		50049	. . 2nd Wheel Assembly (48T and 72T gears for 1.25 cm, 1/2 and 3/4-in. base; 60 cycle drive)	1
	7	50052	. . 3rd Wheel Assembly (72T gear for all drives)	1
	8	50065	. . 5th Wheel Assembly (50T and 64T gears for all drives)	1
	9	50069	. . 6th Wheel Assy (22T and 50T gears for all drives)	1
	10	50275	. . Standoff Plate Assy, Left (with gears for all drives)	1
	11	50303	. . Bracket	1
	12	17064	. . Tension Spring	1
	13	50292	. . Supply Roll Lever Assembly (Left)	1
	14	50294	. . Reroll Lever Assembly (Left)	1

REPLACEMENT PARTS LIST
UNIVERSAL CHART TRANSPORT SUBASSEMBLY

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-6	15	50181	. Supply Roll Stick Assembly	1
	16	50180	. Reroll Stick Assembly	1
	17	50036	. Gear and Hub Assembly (Drive Roll)	1
	18	50249-2	. Tie Bar	1
	19	50020	. Timing Roll Assembly (Drive roll for inch-based drives)	1
		50020-M	. Timing Roll Assembly (Drive roll for metric drives)	1
	20	50253	. Tie Rod	1
	21	50250	. Tie Bar (Lower)	1
	22	50105	. Platen Tie Rod (Writing Table Rod)	1
	23	50032	. Shaft Timing Roll (Right)	1
	24	43006	. "E" Ring, Retainer	1
	25	57051	. End Assembly (Right)	1
	26	50299	. . Shipping Bracket	1
	27	57049	. . Side Plate Assembly (Right)	1
	28	50304	. . Bracket	1
	29	57077	. . Latch Keeper	1
	30	50284	. . Stand-off Plate (Right)	1
	31	50289	. . Reroll Lever Assembly (Right)	1
	32	17064	. . Tension Spring	1
	33	50293	. . Supply Roll Lever Assembly (Right)	1
	34	12440	. . Reroll Clip Bushing	4
	35	40058	. Drive Roll Bushing Assembly (Left Hand)	1
	36	12084	. Set Knob	1
	37	50113	. Platen Lever Assembly (Right)	1
	38	50114	. Platen Lever Assembly (Left)	1
	39	50306	. Washer	2
	40	50307	. Washer	2
	41	50099	. Tear-off Bar	1
	42	50102	. Platen Stripper (Writing Table)	
	43	40058	. Drive Roll Bushing Assembly (Left Hand)	1
	44	52557	Slide, Pen Lifter	1
	45	52555	Spring, Pen Lifter	1
	46	52554	Retaining Pin, Pen Lifter	2
	47	ND40140-5	"E" Ring	2

SECTION IV - CHART DRIVE MODULES

REPLACEMENT PARTS LIST
ET-300 SINGLE-SPEED CHART DRIVE MODULES

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-7		50548	ET-300-15C Chart drive assembly	
		50549	ET-300-15A Chart drive assembly	
		50550	ET-300-1A Chart drive assembly	
		50570	ET-300-1B Chart drive assembly	
	1	40475-2	Motor (B1), 15 rpm, synchronous (300-15C, 300-15A)	1
		40475-3	Motor (B1), 1 rpm, synchronous (300-1A, 300-1B)	
	2	50557	Bracket, Motor support	1
	3	51494	Capacitor, Motor, 1.0 MFD. (C1)	1
	4	50541	Transmission Assy (300-15C)	1
		50531	Transmission Assy (300-15A, 300-1A)	
		50521	Transmission Assy (300-1B)	
	5	50508	Bracket, Transmission support	1
	6	50610	Coupling, Shaft	2
	7	50489	Shaft, Drive	1
	8	50503	Plate Assy, Mounting	1
	9	400330	Switch, Chart drive (SPST) (S2)	1
	10	50482	Bracket, Chart drive switch	1
	11	50608-1	Terminal Strip, Ceramic (TB2)	1
	12	50485	Cover, Ceramic Terminal Strip	1
	13	400330	Switch, Power (SPST) (S1)	1
	14	50588	Bracket, Power switch	1
	15	50609	Terminal Strip (TB1)	1
	16	50605	Shield, Terminal strip	1
	17	50606	Cover, Terminal strip	1
	18	50642	Cable Assembly, Transmission	1
		50644	Cable Assembly, Transmission (with remote control)	
		50658-1	Cable Assembly, (Remote with internal mode switch)	
	19	50604	Panel, Front control	
		50659	Panel, Front control (Used with internal mode switch)	
		50617	Switch, Mode (S3)Optional (Not illustrated)	1
	20	12448	Gear, Manual change (18T, gold)	1
		12454	Gear, Manual change (30T, green)	1
		12460	Gear, Manual change (45T, red)	2
		12466	Gear, Manual change (60T, green)	1
		12472	Gear, Manual change (72T, gold)	1
	21	12476	Nut, knurled change gear	2

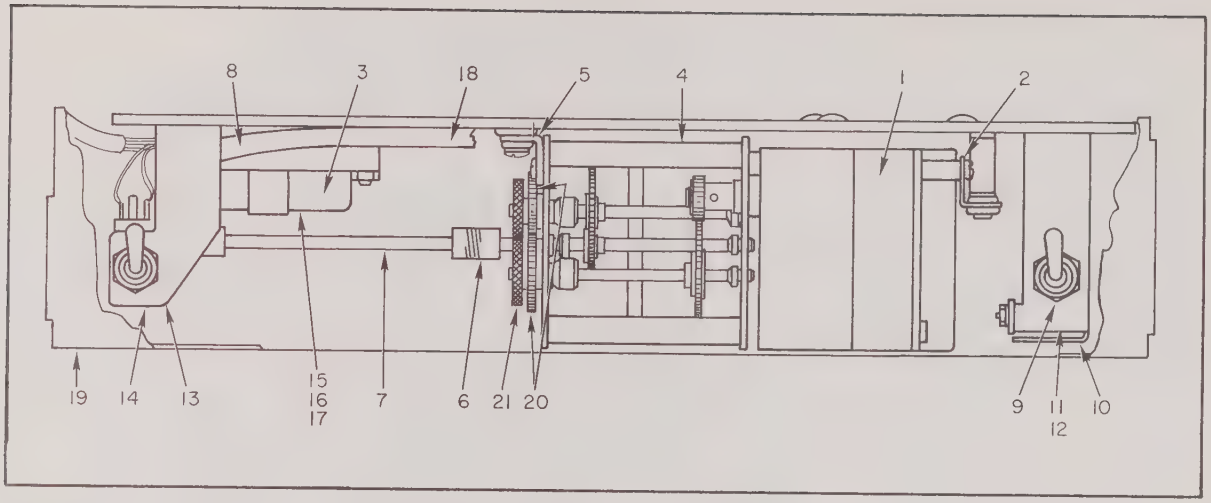


FIGURE 4-7. ET-300 Single Speed Chart Drive Modules.

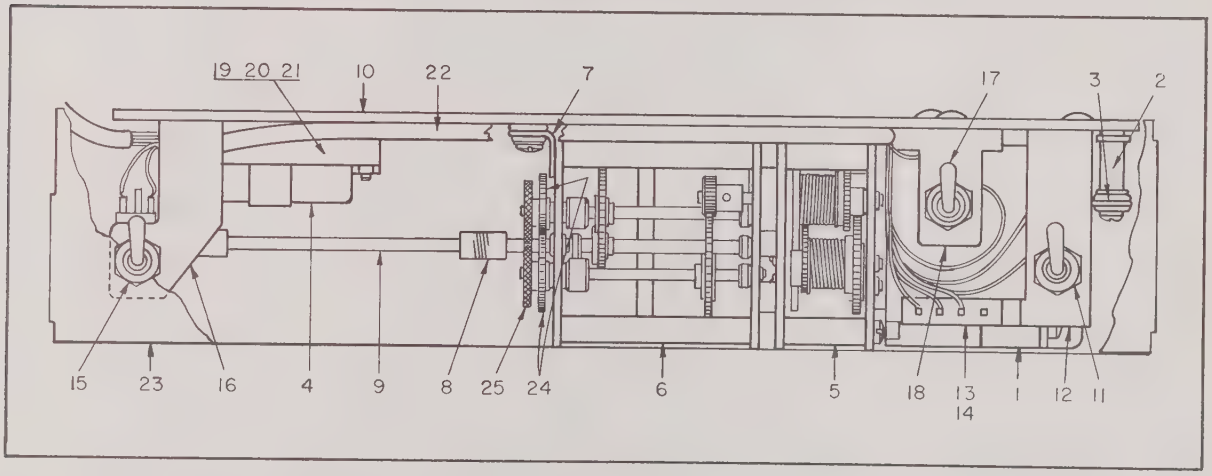


FIGURE 4-8. ET-318 Dual-Speed Chart Drive Modules.

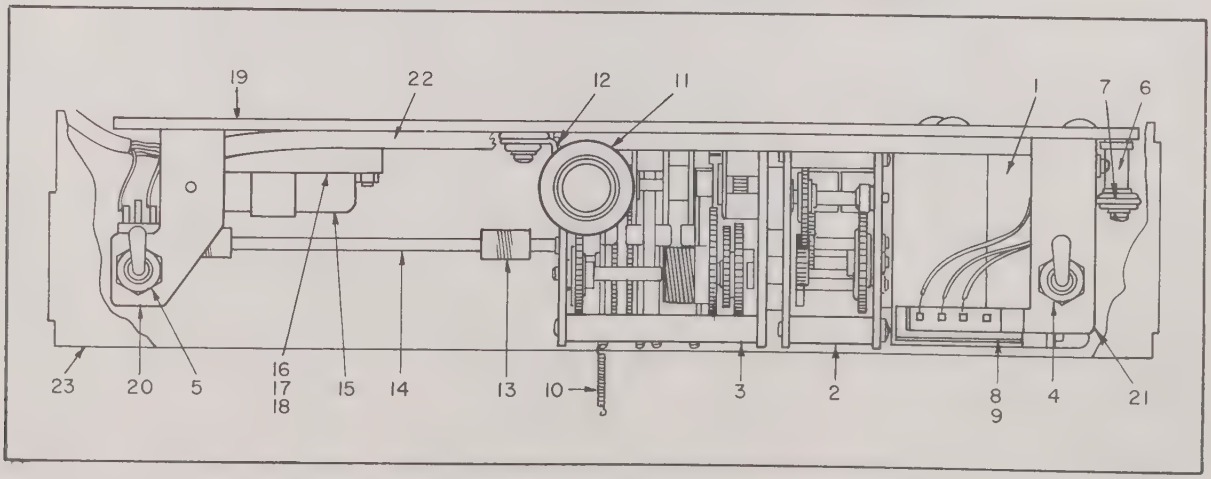


FIGURE 4-9. ET-303 Five-Speed Chart Drive Modules.

ET-318 DUAL-SPEED CHART DRIVE MODULES

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-8		50502-60	ET-318-60 Chart drive assy (2-speed)	1
		50502-30	ET-318-30 Chart drive assy (2-speed)	
		50502-15	ET-318-15 Chart drive assy (2-speed)	
		50502-10	ET-318-10 Chart drive assy (2-speed)	
		50502-6	ET-318-6 Chart drive assy (2-speed)	
	1	40475-2	Motor (B1), 15 rpm, synchronous (Bodine)	1
	2	50558-1	Spacer, Motor support	1
	3	50557	Bracket, Motor support	1
	4	51494	Capacitor, Motor, 1.0 MFD (C1)	1
	5	50560	Gear Box, Dual-speed (60:1)	1
		50530	Gear Box, Dual-speed (30:1)	
		50515	Gear Box, Dual-speed (15:1)	
		50510	Gear Box, Dual-speed (10:1)	
		50506	Gear Box, Dual-speed (6:1)	
	6	50551	Transmission Assy	1
	7	50508	Bracket, Transmission support	1
	8	50610	Coupling, Shaft	2
	9	50489	Shaft, Drive	1
	10	50504	Plate Assy, Mounting	1
	11	400330	Switch, Chart drive (SPST) (S2)	1
	12	50596	Bracket, Chart drive switch	1
	13	50608-1	Terminal Strip, Ceramic (TB2)	1
	14	50485	Cover, Ceramic Terminal Strip	1
	15	400330	Switch, Power (SPST) (S1)	1
	16	50588	Bracket, Power switch	1
	17	50617	Switch, High-Low (SPDT) (S3)	1
	18	50599	Bracket, High-Low switch	1
	19	50609	Terminal Strip (TB1)	1
	20	50605	Shield, Terminal strip	1
	21	50606	Cover, Terminal strip	1
	22	50638	Cable Assembly, Transmission	1
		50640	Cable Assy, Transmission (with remote control)	
		50656-1	Cable Assy, (Remote with internal Mode Switch)	
	23	50465	Panel, Front control	1
		50660	Panel, Front control (Used with internal mode switch)	1
		SWT 1-6	Switch, Mode (S4) Optional (Not illustrated)	
	24	12488	Gear, Manual change (18T gold)	1
		12454	Gear, Manual change (30T green)	1
		12460	Gear, Manual change (45T red)	2
		12466	Gear, Manual change (60T green)	1
		12472	Gear, Manual change (72T gold)	1
	25	12476	Nut, Knurled change gear	2

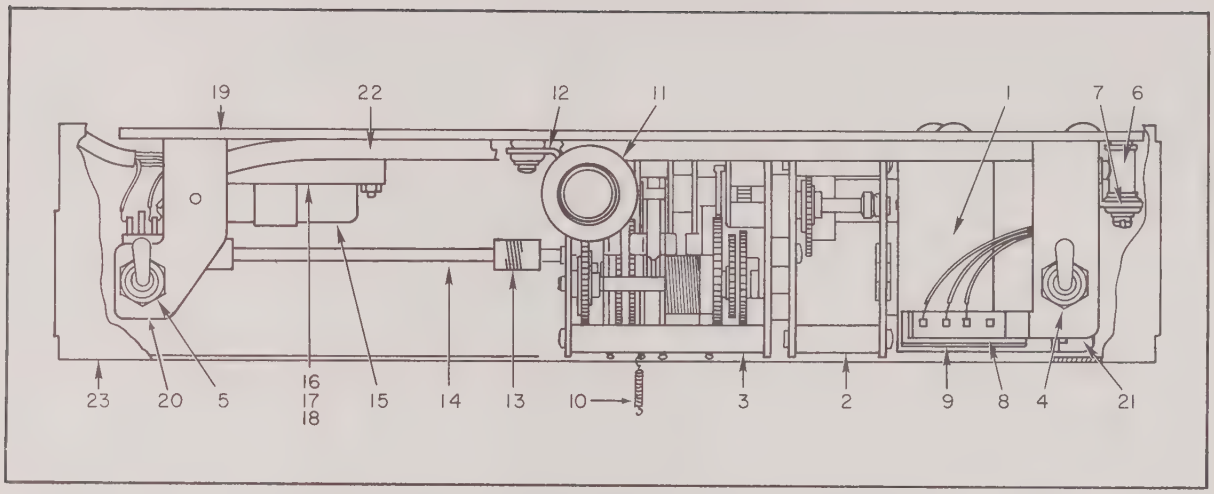


FIGURE 4-10. ET-309 Five Speed Chart Drive Modules.

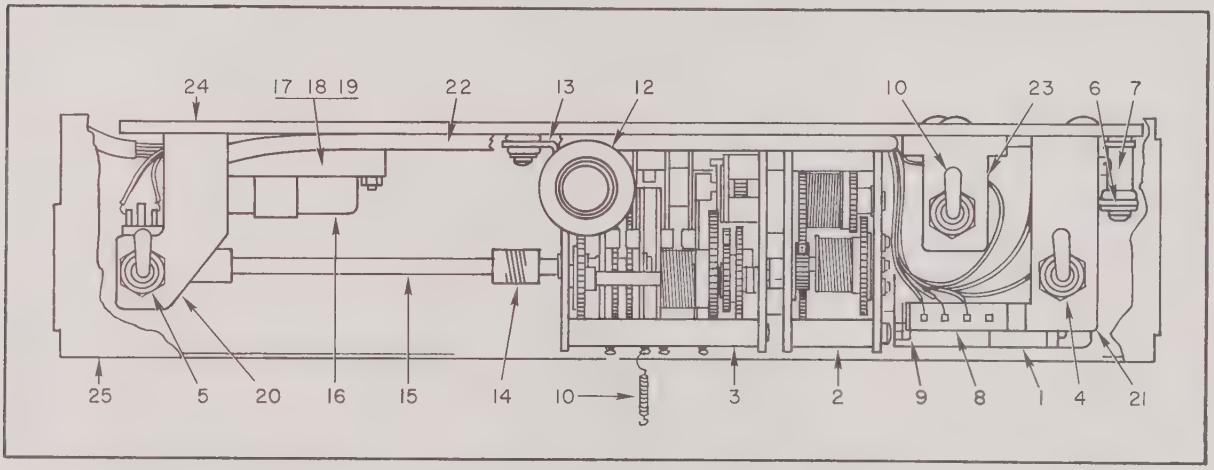


FIGURE 4-11. ET-321 Ten Speed Chart Drive Modules.

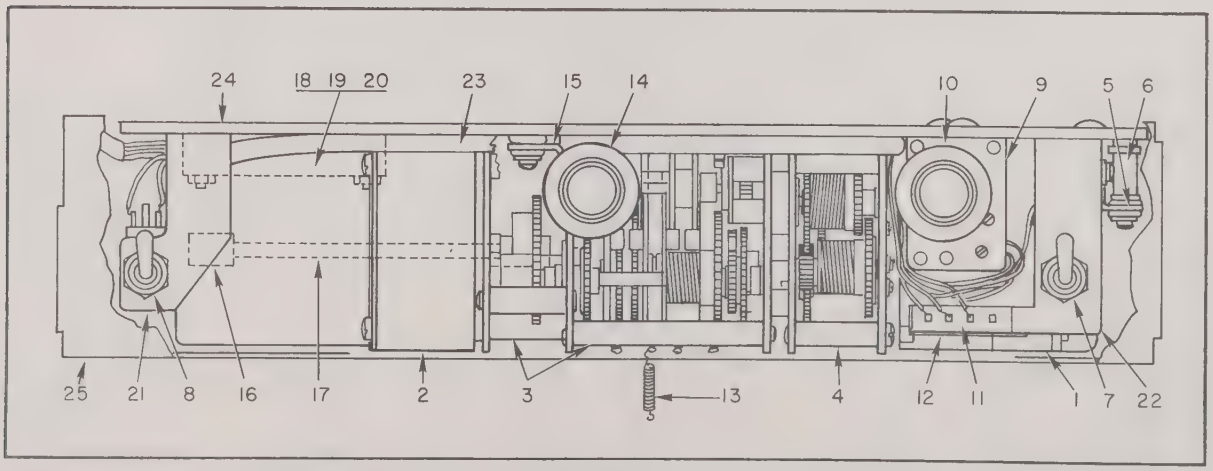


FIGURE 4-12. ET-327 Fifteen Speed Chart Drive Modules.

ET-303 FIVE-SPEED CHART DRIVE MODULES

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-9		50475-60	ET-303-60 Chart Drive Assy (IN or CM/HR)	1
		50475-30	ET-303-30 Chart Drive Assy (IN or CM /HR x 2)	
		50475-15	ET-303-15 Chart Drive Assy (IN or CM/HR x 4)	
		50475-10	ET-303-10 Chart Drive Assy (IN or CM/HR x 6)	
		50475-6	ET-303-6 Chart Drive Assy (IN or CM/HR x 10)	
	1	40475-2	Motor (B1), 15-rpm synchronous (Bodine)	1
	2	50470	Gear Box, Single-speed (IN or CM/HR)	1
		50471	Gear Box, Single-speed (IN or CM/HR x 2)	
		50472	Gear Box, Single-speed (IN or CM/HR x 4)	
		50473	Gear Box, Single-speed (IN or CM/HR x 6)	
		50474	Gear Box, Single-speed (IN or CM/HR x 10)	
	3	50561	Transmission, Fine-speed	1
	4	400330	Switch, chart drive (SPST) (S2)	1
	5	400330	Switch, Power (SPST) (S1)	1
	6	50558-1	Spacer, Motor support	1
	7	50557	Bracket, Motor support	1
	8	50608-1	Terminal Strip, Ceramic (TB2)	1
	9	50485	Cover, Ceramic Terminal Strip	1
	10	50622	Spring, Cam Tensioning	4
	11	50464	Knob, Inches selector (for 1/2-in. base drive)	1
		50598	Knob, Inches selector (for 3/4-in. base drive)	
		50478	Knob, Centimeters selector (for metric drive)	
	12	50508	Bracket, Transmission support	1
	13	50610	Coupling, Shaft	2
	14	50489	Shaft, Drive	1
	15	51494	Capacitor, Motor, 1.0 MFD (C1)	1
	16	50609	Terminal Strip (TB1)	1
	17	50606	Cover, Terminal strip	1
	18	50605	Shield, Terminal strip	1
	19	50524	Plate Assy, Mounting	1
	20	50588	Bracket, Power switch	1
	21	50596	Bracket, Chart drive switch	1
	22	50642	Cable Assy, Transmission	1
		50644	Cable Assy, Transmission (with remote control)	
		50657-1	Cable Assy, (Remote with internal Mode switch)	
	23	50457	Panel, Front control (ET-303-60 IN-base drives)	1
		50458	Panel, Front control (ET-303-30 IN-base drives)	
		50459	Panel, Front control (ET-303-15 IN-base drives)	
		50460	Panel, Front control (ET-303-10 IN-base drives)	
		50461	Panel, Front control (ET-303-6 IN-base drives)	
		50362	Panel, Front control (ET-303-60 metric drive)	
		50361	Panel, Front control (ET-303-60 metric drive)	
		50360	Panel, Front control (ET-303-15 metric drive)	
		50359	Panel, Front control (ET-303-10 metric drive)	
		50358	Panel, Front control (ET-303-6 metric drive)	
		50661-*	Panel, Front control (For internal mode switch - note drive)	
		50617	Switch, Mode (S3) optional (Not illustrated)	

ET-309 FIVE-SPEED CHART DRIVE MODULE

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-10		50476	ET-309 Chart Drive Assy(IN or CM/MIN)	1
	1	40475-2	Motor (B1), 15 rpm, synchronous (Bodine)	1
	2	50479	Gear Box, Single-speed (IN or CM/MIN)	1
	3	50561	Transmission, Five-speed	1
	4	400330	Switch, Chart drive (SPST) (S2)	1
	5	400330	Switch, Power (SPST) (S1)	1
	6	50558-1	Spacer, Motor support	1
	7	50557	Bracket, Motor support	1
	8	50608-1	Terminal Strip, ceramic (TB2)	1
	9	50485	Cover, Ceramic terminal strip	1
	10	50622	Spring, Cam tensioning	4
	11	50464	Knob, Inches selector (For IN-base drive)	1
		50473	Knob, Centimeters selector (for metric drive)	
	12	50508	Bracket, Transmission support	1
	13	50610	Coupling, Shaft	2
	14	50489	Shaft, Drive	1
	15	51494	Capacitor, Motor, 1.0 MFD. (C1)	1
	16	50609	Terminal Strip (TB1)	1
	17	50606	Cover, Terminal strip	1
	18	50605	Shield, Terminal strip	1
	19	50524	Plate Assy, Mounting	1
	20	50588	Bracket, Power switch	1
	21	50596	Bracket, Chart drive switch	1
	22	50642	Cable Assy, Transmission	1
		50644	Cable Assy, Transmission (with remote control)	
		50657-1	Cable Assy, Remote with internal Mode switch	
	23	50462	Panel, Front control (inch based drives)	
		50357	Panel, Front control (metric drive)	
		50661-*	Panel, Front control (for internal mode switch - note drive)	
		50617	Switch, Mode (S3) optional (Not illustrated)	

TEN SPEED CHART DRIVE MODULES
ET-321-6, ET-321-10, ET-321-15, ET-321-30 and ET-321-60

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-11		50501-60	ET-321-60 Chart Drive Assy, 10-speed (IN or CM/HR)	
		50501-30	ET-321-30 Chart Drive Assy, 10-speed (IN or CM/HR x 2)...	
		50501-15	ET-321-15 Chart Drive Assy, 10-speed (IN or CM/HR x 4)...	
		50501-10	ET-321-10 Chart Drive Assy, 10-speed (IN or CM/HR x 6)...	
		50501-6	ET-321-6 Chart Drive Assy, 10-speed (IN or CM/HR x 10)..	
	1	40475-2	Motor (B1), 15 rpm, synchronous (Bodine)	1
	2	50560	Gear Box, Dual-speed (IN or CM/HR).....	1
		50530	Gear Box, Dual-speed (IN or CM/HR x 2)	
		50515	Gear Box, Dual-speed (IN or CM/HR x 4)	
		50510	Gear Box, Dual-speed (IN or CM/HR x 6)	
		50506	Gear Box, Dual-speed (IN or CM/HR x 10)	
	3	50561	Transmission, Five-speed	1
	4	400330	Switch, Chart drive (SPST) S2	1
	5	400330	Switch, Power (SPST) S1	1
	6	50558	Spacer, Motor support	1
	7	50557	Bracket, Motor support	1
	8	50608-1	Terminal Strip, Ceramic (TB2)	1
	9	50485	Cover, Ceramic terminal strip.....	1
	10	50617	Switch, HR-MIN (SPDT) S3	1
	11	50622	Spring, Cam tensioning	4
	12	50464	Knob, Inches selector (1/2-in. base drive)	1
		50598	Knob, Inches selector (3/4-in. base drive)	
		50478	Knob, Centimeters selector (Metric drive)	
	13	50508	Bracket, Transmission support	1
	14	50610	Coupling, Shaft.....	2
	15	50489	Shaft, Drive	1
	16	51494	Capacitor, Motor, 1.0 MFD (C1)	1
	17	50609-1	Terminal Strip (TB1).....	1
	18	50606	Cover, Terminal strip	1
	19	50605	Shield, Terminal strip	1
	20	50588	Bracket, Power switch	1
	21	50596	Bracket, Chart drive switch	1
	22	50638	Cable Assy, Transmission	1
		50640	Cable Assy, Transmission (with remote control).....	
		50656-1	Cable Assy, (Remote with internal Mode switch).....	
	23	50599	Bracket, SPDT switch (HR-MIN)	1
	24	50504	Plate Assy, Mounting	1
	25	50628	Panel, Front control (for ET-321-60 IN. -base drives).....	
		50629	Panel, Front control (for ET-321-30 IN. -based drives).....	
		50630	Panel, Front control (for ET-321-15 IN. -based drives).....	
	25	506031	Panel, Front control (For ET-321-10 IN. -based drives)	
		506032	Panel, Front control (for ET-321-6 IN. -based drives)	
		50367	Panel, Front control (for ET-321-60 metric drive).....	
		50366	Panel, Front control (for ET-321-30 metric drive).....	
		50365	Panel, Front control (for ET-321-15 metric drive).....	
		50364	Panel, Front control (for ET-321-10 metric drive).....	
		50363	Panel, Front control (for ET-321-6 metric drive).....	
			Panel, Front control (internal Mode Switch) See data sheet..	
		SWT 1-6	Switch, Mode (S4) Optional (Not illustrated)	

FIFTEEN-SPEED CHART DRIVE MODULE ET-327

Fig. No.	Index No.	Part No.	Description	Qty Per Unit
4-12		50500	ET-327 Chart drive assy, 15-speed	1
	1	40475-2	Motor (B1), 15 rpm, synchronous (Bodine)	1
	2	44360-1	Motor (B2), 120 rpm, synchronous (Globe)	1
	3	50571	Transmission Assy	1
	4	50560	Gear Box, Dual speed	1
	5	50558	Spacer, Motor support	1
	6	50557	Bracket Assy, Motor support	1
	7	400330	Switch, Chart drive (SPST) (S2)	1
	8	400330	Switch, Power (SPST) (S1)	1
	9	50595	Switch Assy, Control (HR-MIN-SEC) (S3)	1
	10	50463	Knob, Selector switch (HR-MIN-SEC)	1
	11	50608	Terminal strip, ceramic (TB2)	1
	12	50485	Cover, Ceramic terminal strip	1
	13	50622	Spring, Cam tensioning	4
	14	50464	Knob, Inches selector (1/2-in. base drive)	1
		50598	Knob, Inches selector (3/4-in. base drive)	
		50478	Knob, Centimeters selector (metric drive)	
	15	50508	Bracket Assy, Transmission support	1
	16	50610	Coupling, Shaft	2
	17	50489	Shaft, Drive	1
	18	50609-1	Terminal strip (TB1)	1
	19	50606	Cover, Terminal strip	1
	20	50605	Shield, Terminal strip	1
	21	50588	Bracket, Power switch	1
	22	50581	Bracket, Chart drive switch	1
	23	50634	Cable Assy, Transmission	1
		50636	Cable Assy, Transmission (with remote control)	
	24	50505	Plate Assy, mounting	1
	25	50633	Panel, Front control (for inch-based drives)	1
		50368	Panel, Front control (for metric drive)	
		*	Panel, Front control (for internal Mode switch)	See Data Sheet
		51494	Capacitor, Motor (C1), 1.0 MFD (Mounts in case)	1
		40534	Capacitor, Motor (C2, C3), 1.5 MFD (Mounts in case)	2
		43541	Switch, Mode (S302) Optional (Mounts on chassis)	1

PART 5
APPENDIX

GENERAL

Part 5 of this manual contains supplemental information covering optional features of the recorder. This includes instructions for accessory attachments and all of the required documentation for special instrument modifications requested by the purchaser.

When applicable, the Appendix will also include production change notices which will describe the latest design improvements as well as any necessary corrections to the rest of the manual.

The DATA SHEET for your recorder will be found in a separate envelope bound in the back of the manual. This document is a customized specification form that accurately describes the instrument supplied. Refer to the DATA SHEET for a description of your instrument, the accessories supplied, the serial number, and any special assembly numbers.

ATTENTION: Do not misplace the DATA SHEET; always keep it in the envelope provided.

EVENT PENS

Event pens are attachments designed to record "on-off" indications on the margins, outside of the ruled portion of the chart paper, while the analog record is made on the chart. The time duration of the occurrence may be recorded in relation to the analog recording. One to four event pens can be mounted on the recorder and are identified as either the Left Hand Pen, Left Hand-Center Pen, Right Hand-Center Pen, or Right Hand Pen - channels 1, 2, 3, 4 respectively.

An event pen is actuated by the electromagnet which is a part of each complete event pen assembly. When voltage (the signal to be recorded) is applied to the coil of the electromagnet, the pen is displaced from its off position. When the voltage is removed, the pen returns to the normal off or rest position.

The leads of the magnet coil are connected to the input terminal block mounted on the rear of the case (See Figure 3-3). The terminal block is made accessible when the cover plate on the rear of the case is removed. Electrical input ratings are specified on the Terminal Code Plate, also located on the rear of the case.

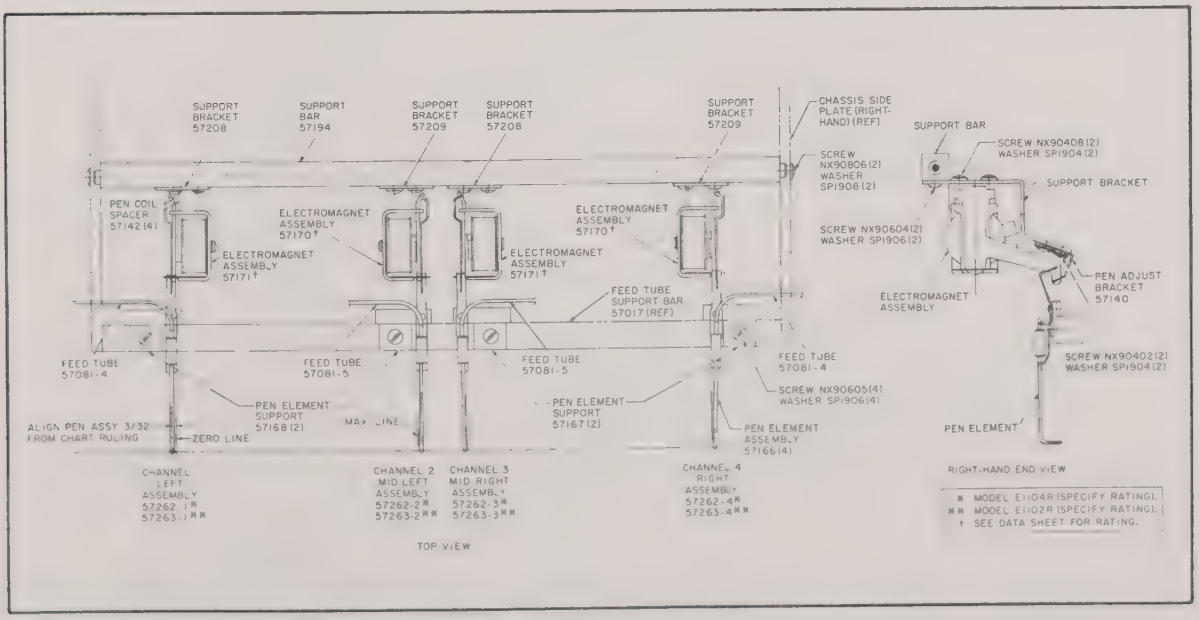


FIGURE A1. Event Pens.

Ink is supplied to the event pens from the same inkwells that are used for the analog channels. Priming and maintenance procedures for the event pens are also the same as that described for the analog pens in PART 3 of the manual. See the instrument Data Sheet for assembly part numbers.

IMPEDANCE MATCHING AMPLIFIER

The Impedance Matching Amplifier is an Esterline Angus accessory for coupling conventional low impedance circuits to standard graphic recorders. This transistorized amplifier reduces the effective input resistance of the recorder and stabilizes response time by causing the measuring element to appear critically damped regardless of external circuit conditions.

Matching is accomplished by making use of the input and output impedance characteristics of a current sensitive transistor amplifier as shown in Figure A2. This linear amplifier has a nonpolarized input and a unity-gain and amplification factor. Connections to the measuring circuitry of the recorder are shown in Figure 3-12.

Due to its compact solid-state construction, the amplifier and its built-in power supply is normally mounted inside the recorder case. It is also available as a separate unit for field installations. It has been especially designed for Esterline Angus recorders with 0-1ma measuring elements. Consult the factory for details regarding other special applications.

Impedance Matching Amplifier Parts List

	21557	Amplifier Assy. (complete)
Q1	21586	Transistor, PNP 2N1309
Q2	21584	Transistor, NPN 2N1308
CR1	40801	Silicon Rectifier 1N3755
CR2	40801	Silicon Rectifier 1N3755
CR3	21587	Germanium Diode 1N2326
CR4	21587	Germanium Diode 1N2326
C1	14440-75	Capacitor, 75mfd @ 25V, Electrolytic .....
C2	14440-75	Capacitor, 75mfd @ 25V, Electrolytic .....
R1	21566-*	Resistor, 1%, Selected ...
R2	Not Req'd.	Resistor .....
R3	RCC-2-102	Resistor (See R4) .....
R4	RCC-2-102	Resistor, 1000Ω , 10% 1/2 Watt, Carbon .....
R5	RCC-2-101	Resistor, 100Ω , 10% 1/2 Watt, Carbon .....
R6	RCC-2-103	Resistor, 10K, 10% 1/2 Watt, Carbon .....
R7	*	Resistor, 1%, Selected, Optional .....
T1	21564-5	Power Transformer .....

*See Data Sheet

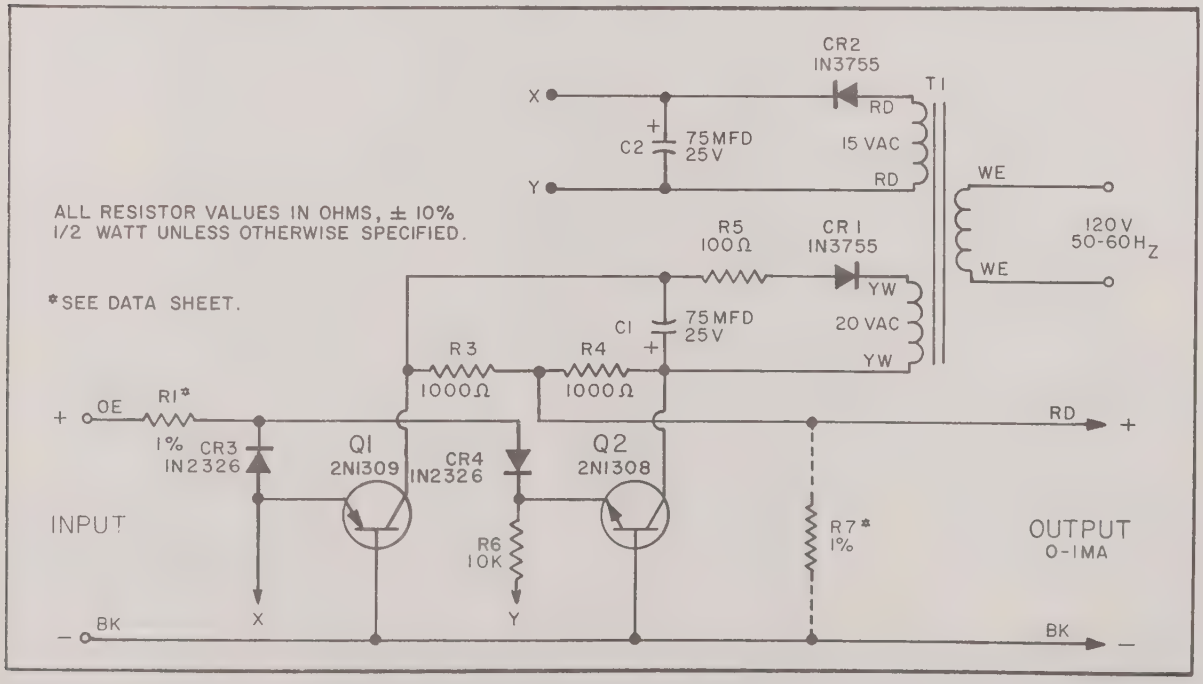


FIGURE A2. Schematic Diagram Of Impedance Matching Amplifier No. 21557.

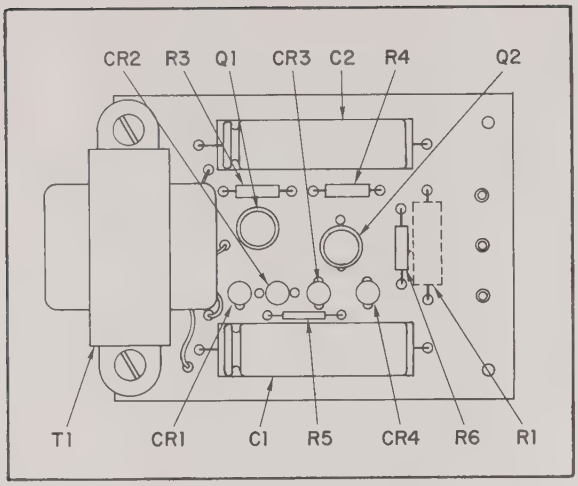


FIGURE A3. Top View Of Amplifier Assembly.

DC MICROAMMETER AND MILLIVOLTMETER

The Esterline Angus RectiGRAPH DC microammeters and Millivoltmeters have sensitivities of 10 microamperes and 10 millivolts respectively. This high sensitivity of the instrument makes possible its use in most circuits without additional signal amplification. Optional connections for high or low input impedance can be made because of the impedance matching amplifier and the magnetic amplifier used in the measuring element system. Refer to TABLE 3-1 in this manual for measuring system specifications.

ELECTRIC PEN LIFTER

The electric pen lifter is an option designed to allow the operator to locally or remotely lift the recording pens from the graph paper by the application of electric power.

When power is applied to the solenoid in the pen lifter assembly, the pen lifter bar is raised through electro-mechanical action. When voltage is removed from the solenoid, the pen lifter bar drops to its normal position, allowing the pens to resume their recording notations on the graph paper.

The electric pen lifter assembly is attached to the right-hand scale mounting bracket as shown in Figure A4. The leads of the pen lifter solenoid are attached to the accessory terminal block located on the back of the chassis as shown in Figure A5.

The power leads are connected to the input terminal block mounted on the rear of the case (see Figure 3-3 in this manual). The input terminal block is made accessible by removal of the rear cover plate on the case. Electrical input ratings are specified on the Terminal Code Plate, also located on the rear of the case.

Rapid Response Expanded-Scale Voltmeter

Esterline Angus Expanded Scale AC Voltmeters are available with a rapid (1/10 second full scale) response. A permanent-magnet, moving-coil measuring element is employed.

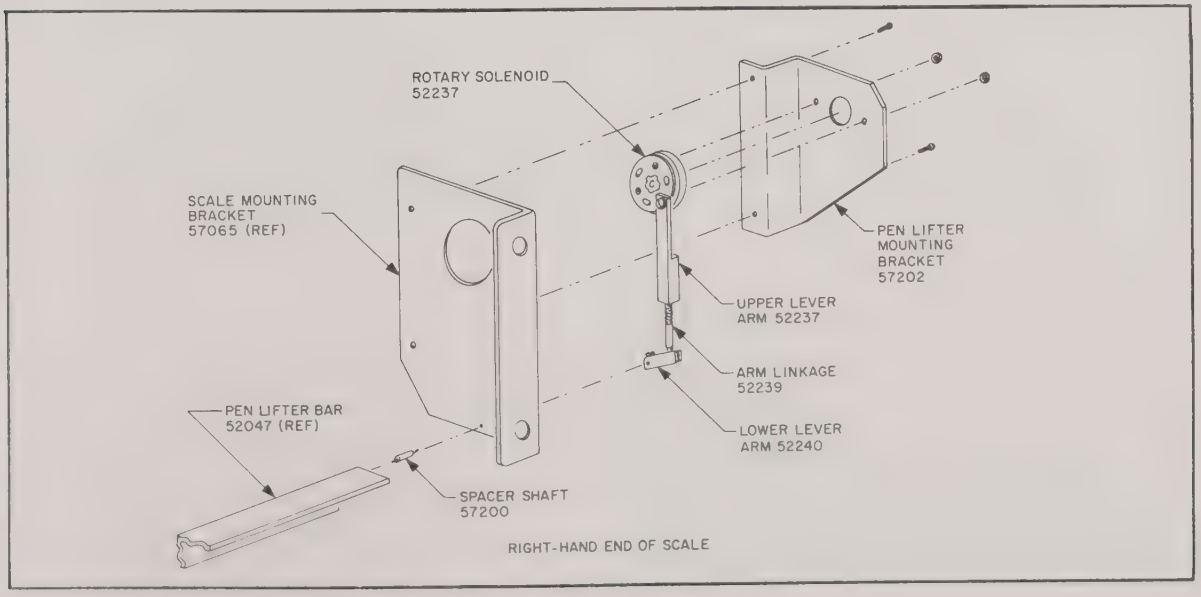


Figure A4. Electric Pen Lifter Assembly No. 57203

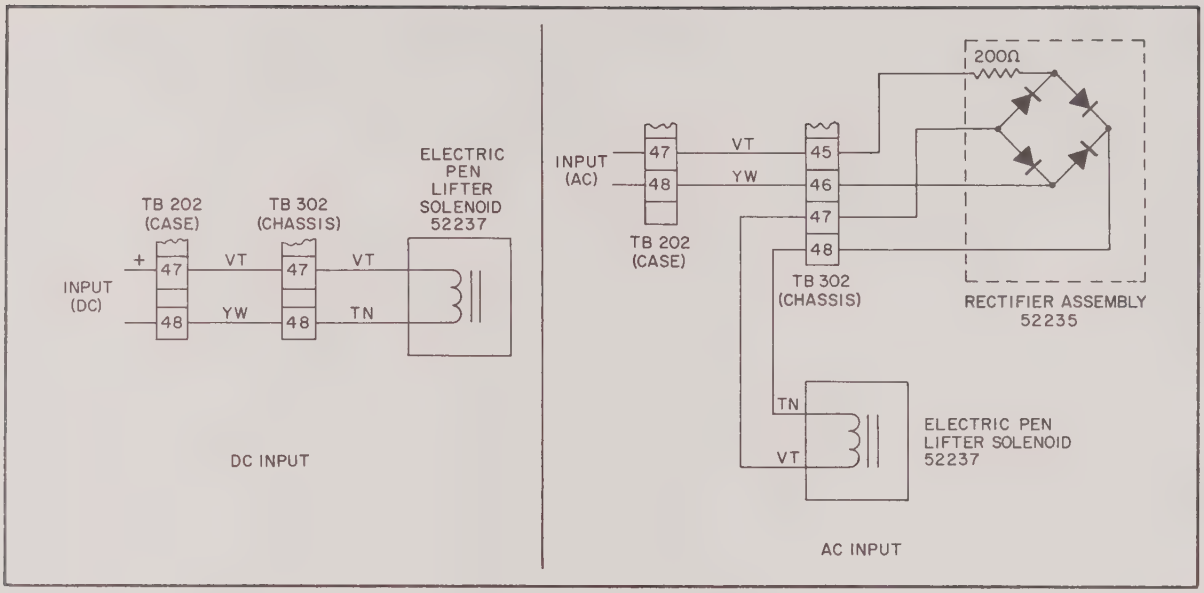


Figure A5. Schematic for Electric Pen Lifter.

The upper one-fourth of the range being measured covers the upper 80 percent of the chart span. The remainder of the voltage range is condensed in the lower 20 percent of the chart span. The recorder operates at frequencies from 50 to 60 Hz. It may also be calibrated for higher frequencies such as 400 Hz.

The recorder uses a rectifier and filter circuit and is calibrated in terms of RMS values for sine wave inputs. Compensation is added to minimize the effects of common sine wave distortions. Schematics of these circuits are shown in Figure 3-12 of this manual. The schematic shown in Figure A6 represents the suppression and matching subassembly required only in the two channel rapid-response voltmeters.

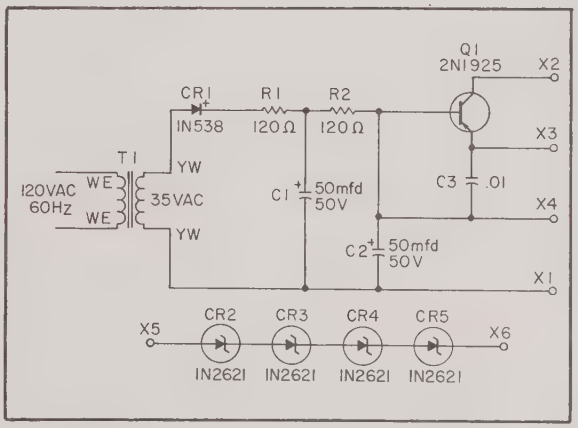


FIGURE A6. Schematic Of 14365-A Subassembly.

Standard Specifications:

Range ..... 0-90 - 130VAC
0-100 - 140VAC
0-180 - 260VAC
0-200 - 280VAC
0-360 - 520VAC
0-400 - 560VAC
Accuracy ..... 1% of midscale voltage
Frequency Limits ..... 50-60 Hz
Current at Full Scale 225ma
Response....1/10 second for full voltage reading
Ambient Temperature Range....±20° to ±120°F.

APPENDIX
CHANGE NOTICE

INSTRUCTION MANUAL REVISIONS

A number of design changes have been incorporated into recent productions of the Model E1102R and Model E1104R RectiGRAPH Recorders. As a result of these production changes, the following modifications should be made to instruction manual No. M57250-1.

MANUAL PAGE NO. AND ITEM	DESCRIPTION OF REVISION
Page 3-16, Fig. 3-13.	Reverse terminals #39 and #40 in Remote Control diagrams (Fig. 1 thru Fig. 5).
Page 4-11, Part No. 57053-60.	Change "3/4-in base" to "1/2-in base".
Page 4-13, Index No. 12.	Change Part No. 50485 to 50397.
Pages 4-13, 4-15, 4-17, 4-18, and 4-19; Part No's. 50605, 50606 & 50609.	Remove from parts listings and figure illustrations.
Page 4-13, Index No. 18 (Alternate).	Change Part No. 50658-1 to 50671-1.
Pages 4-15, 4-17, 4-18 and 4-19.	Change Part No. 50596 to 50581.
Pages 4-15 and 4-19.	Change Part No. SWT 1-6 to 50650
Pages 4-17 and 4-18, Index No. 22 (Alternate).	Change Part No. 50657-1 to 50671-1
Page 4-17, Index No. 23, Part No. 50361.	Change "ET-303-60" to "ET-303-30".
Page 4-19, Index No. 25, (Alternates).	Change Part No. 506031 to 50631, and 506032 to 50632. Add Part No. 50662 for Panel (internal Mode Switch).

CASE MODIFICATION

A new door assembly is now being installed on all recorder cases. This design change has caused instructions in the standard manual to be changed.

The "CASE DOOR REMOVAL" procedure in PART 1, and the "REPLACEMENT PART LIST" in PART 4 should be amended as follows:

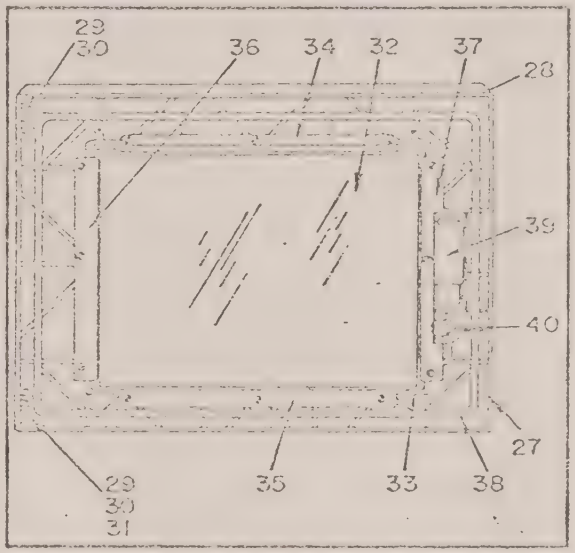
Removal Procedure

1) OPEN CASE DOOR. REMOVE BOTTOM HAIR PIN COTTER FROM THE HINGE PIN IN UPPER LEFT-HAND CORNER OF THE DOOR. NORMALLY, A SLIGHT JIGGLING OF THE DOOR SHOULD CAUSE THE HINGE PIN TO DROP DOWN, THUS RELEASING THE TOP HINGE PIN FROM THE CASE. IF HINGE PIN DOES NOT DROP DOWN BY ITSELF, MANUALLY PUSH THE PIN DOWNWARD.

2) AFTER TOP HINGE PIN IS RELEASED FROM THE CASE, TILT DOWN FRONT END OF DOOR UNTIL TOP EDGE OF DOOR CLEARS THE TOP FLANGE OF THE CASE.

3) LIFT UP DOOR TO RELEASE LOWER HINGE PIN FROM BOTTOM FLANGE OF CASE. REMOVE DOOR ASSEMBLY.

CAUTION: DO NOT LOSE SPACING WASHERS WHEN REMOVING DOOR. NOTE NUMBER AND LOCATION OF WASHERS THAT ARE USED.



REPLACEMENT PARTS LIST

INDEX NO.	PART NUMBER	DESCRIPTION	QTY.
27	51700-*-**	DOOR ASSEMBLY (LESS LIGHTING)	1
--	51701-*	.DOOR (LESS ATTACHING PARTS)	1
28	19840 *	.NAMEPLATE	1
29	51703 .	.PIN, DOOR HINGE	2
30	51713-1	.COTTER PIN, HAIR	4
31	51342-1	.WASHER	1
32	51576**	.GLASS, DOOR (STANDARD TYPE, DOUBLE-STRENGTH GLASS)	1
33	0660	.GASKET, GLASS (SPECIFY LENGTH)	1
34	51705	.RETAINING CLIP, DOOR GLASS (TOP)	1
35	51704	.RETAINING CLIP, DOOR GLASS (BOTTOM)	1
36	51707	.RETAINING CLIP, DOOR GLASS (HINGE SIDE)	1
37	51706	.RETAINING CLIP, DOOR GLASS (LATCH SIDE)	1
38	19824	.GASKET, DOOR	1
39	51538	.LATCH ASSEMBLY, FLUSH	1
40	19839	.LOCK ASSEMBLY, DOOR (WITH KEYS)	1

* SPECIFY COLOR AND REFER TO DATA SHEET.

** FOR NON-STANDARD TYPE GLASS, REFER TO DATA SHEET.

CHANGE NOTICE

NEW INKWELL CONFIGURATION

IN LATER PRODUCTION VERSIONS, THE INKWELL HAS BEEN REDESIGNED TO EFFECT THE FOLLOWING CHANGES:

1. INKWELL CAPACITY CHANGED FROM 1 1/2 OUNCES TO 1 OUNCE.

2. THE VENTING SYSTEM OF THE INKWELL HAS BEEN CHANGED. INSTEAD OF THE SLIDING VENT-TUBE SLEEVE AND VENT TUBE SHOWN IN FIG. 3-5 UNDER THE "INKING INSTRUCTIONS" (SEE PART 3, SECTION II OF THE MANUAL), THE INKWELL HAS BEEN CHANGED AS SHOWN IN FIG. 1.

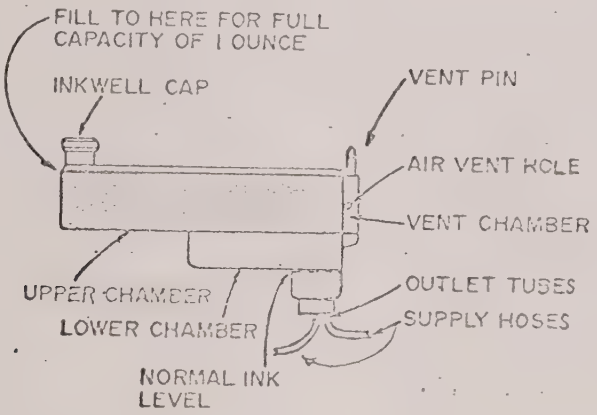


FIG. 1. NEW INKWELL CONFIGURATION

THE ORIGINAL DESIGN OF THE VENT TUBE AND MOVABLE VENT SLEEVE HAS BEEN CHANGED TO A METAL CYLINDRICAL VENT PIN THAT CAN BE MOVED UP AND DOWN IN A VENT CHAMBER. THE VENT CHAMBER IS NOW AN INTEGRAL MOLDED PART OF THE INKWELL. AS SHOWN IN FIG. 1, THE AIR VENT HOLE IS LOCATED IN THE VENT CHAMBER.

3. FILLING THE NEW INKWELL: IN REGARDS TO THE NEW INKWELL VENTING SYSTEM, THE INSTRUCTIONS FOR FILLING THE NEW INKWELL ARE REVISED AS FOLLOWS (REFER TO FIG. 1.):

   A. BEFORE REMOVING THE INKWELL CAP, PUSH THE VENT PIN DOWNWARD SO THAT AIR VENT HOLE IS SEALED OFF FROM THE ATMOSPHERE.

   B. REMOVE INKWELL CAP. USE FILLER SYRINGE AND FILL UPPER CHAMBER WITH INK. THE LOWER CHAMBER WILL AUTOMATICALLY FILL TO ONLY THE NORMAL LEVEL INDICATED IN FIG. 1.

c. Replace inkwell cap. Lift vent pin upward so that air vent hole is open to the atmosphere.

4. Shutdown of the Recorder: In regards to the new inkwell venting system, the instructions under "Shutdown" in PART 3, Section III of the manual should be revised as follows:

Whenever reference is made to "closing the air hole", push the vent pin downward. Whenever reference is made to "opening the air hole", pull the vent pin upward.

PARTS LIST REVISIONS

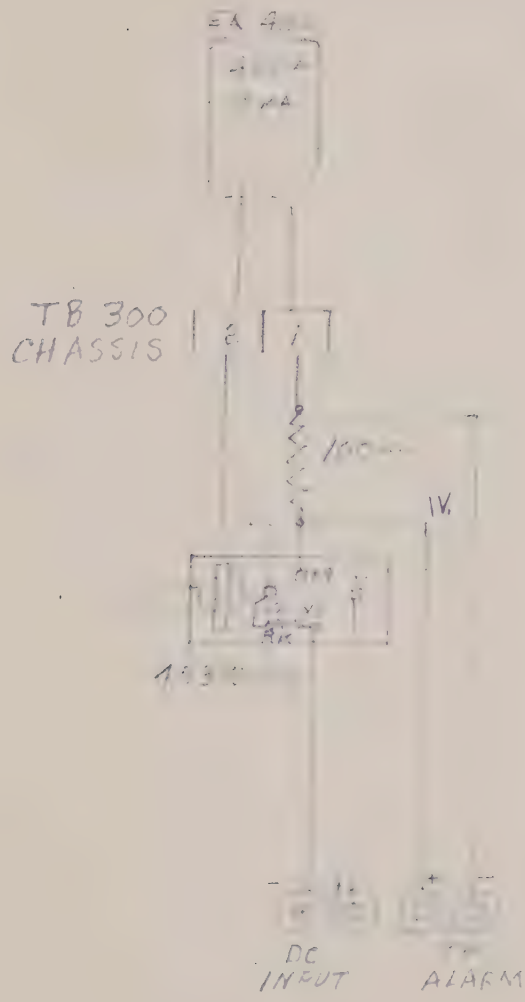
The part number of the new inkwell assembly (Item 2 in Fig. 4-2 of the manual) has been changed from #61323-* to #61400-*.

*NOTE: The suffix number following the dash indicates the number of outlet supply tubes at the bottom of the inkwell.

INSTRUCTION MANUAL REVISIONS

MANUAL PAGE NO. AND ITEM	DESCRIPTION OF REVISION
Page 4-11, Part No. 50039	Change "(23T gear for 1/2-in. and 1.25cm 50 cycle drive)" to "(22T gear for 1/2-in. and 1.25cm, 50/60 cycle drives)."
Page 4-11, Part No. 50078	Change "(22T gear for 1/2-in. and 1.25cm 60 cycle drive)" to "(33T gear for 3/4-in., 50/60 cycle drives)."
Page 2-19 under "LUBRICATION", and page 2-20 (Fig. 2-21).	The synchronous chart drive motor is now lubricated through only one yellow hole.

DC. MILLIVOLTMETER WITH AMPLIFIER
WITH OUTPUT TO ALARM



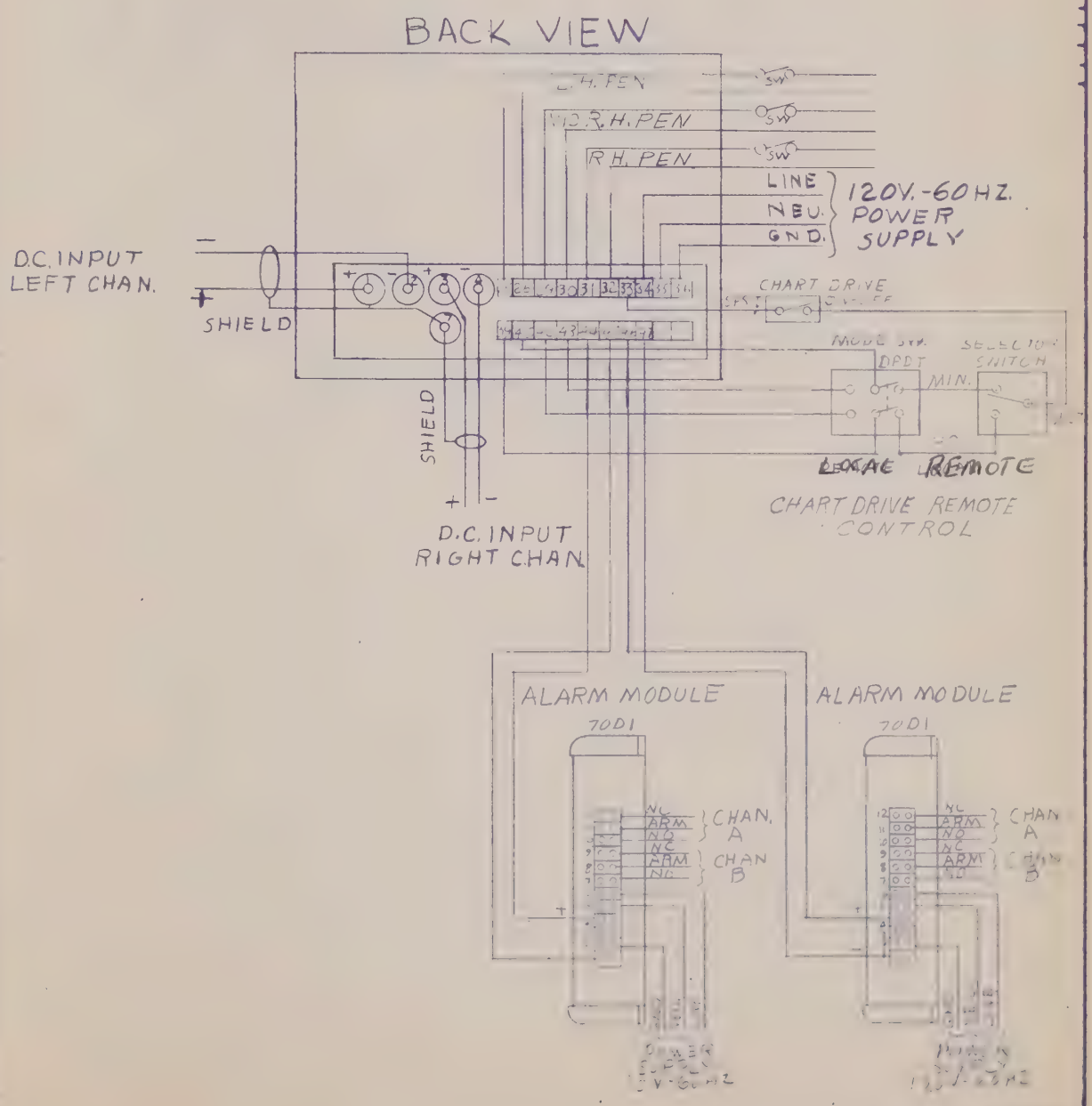
SEE EXTERNAL CONNECTION
DIAGRAM FOR TERM. LOCATION.

M-6439A
752761
REF. G-1142

G-1142

4-2-72

DIAGRAM OF CONNECTIONS
FOR MODEL E1102R
ESTERLINE ANGUS TYPE GRAPHIC
TWO CHANNEL DC. MILLIVOLTMETER WITH AMPLIFIERS



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IMPORTANT

TECHNICAL DATA

ENCLOSED

IMPORTANT

TECHNICAL DATA

ENCLOSED

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CHANGE NOTICE SUMMARY

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